An assessment of variation within IAS 41 compliant methodology used in South Africa to estimate the value of pulpwood plantations

By

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ABSTRACT

This study sought to assess the possible variations within International Accounting Standard (IAS) 41 compliant valuation methodologies used within South Africa to estimate the value of pulpwood plantations.

IAS 41 compliant valuation models were collected from valuation consultants and companies active within the South African forestry sector. Along with the collection of models, model input parameters and methods for the determination of input parameters were retrieved. Models were amended to accept default standardised inputs. These default inputs consisted of case study plantation data sourced from an unnamed plantation in South Africa. Valuations were calculated for this case study plantation using the various models, and used to assess the possible variances between model valuation outputs. In this way the variances derived from the different model mechanisms could be compared to each other. A sensitivity analysis was then performed in order to understand the effect of each parameter upon the valuation output of each model.

This study indicated that there are significant differences between valuation outputs as calculated from a range of IAS 41 compliant valuation models. The collected parameters and parameter classification data also highlighted that certain parameters, age class and growth rate in particular, were being calculated or determined in different ways by users resulting in further sources of potential variance in the calculated values produced by the models.

The study concluded with an evaluation of each of the six unique models in the study. Two main aspects were identified that need to be addressed namely: (i) The standardisation of a model to be used for all valuation purposes; (ii) The provision of rigid guidelines regarding the standardisation of model input parameters.

OPSOMMING

Die studie onderneem om die moontlike variasie tussen waardasie metodes wat in Suid Afrika gebruik word om die waarde van pulphoutplantasies te bepaal en wat aan die Internasionale Rekenkundige Standaard (IRS) 41 voldoend te evalueer.

Waardasie modelle wat aan die IRS 41 voldoen is versamel van waardasie konsultante en maatskappye betrokke in die Suid Afrikaanse bosbou sektor. Saam met die versamelde modelle is model inset parameters en metodes vir die bepaling van inset parameters verkry. Modelle is verander om standard insette te aanvaar. Hierdie standard insette bestaan uit gevallestudie plantasie data wat verkry is vanaf ‘n annonieme plantasie in Suid Afrika. Waardasies is uitgevoer vir die gevallestudie plantasie deur middel van die verskillende modelle en uitsette is gebruik om die variansie tussen modelle te evalueer. Deur hierdie metode kon die variasie weens die verskillende model meganismes met mekaar vergelyk word. ‘n Sensitiwiteitsontleding is uitgevoer om die effek van elke parameter op die waardasie uitsette van elke model te verstaan.

Die studie dui aan dat daar beduidende verskille tussen waardasie uitsette is, soos bereken met die reeks van waardasie modelle wat aan IRS 41 voldoende. Die versamelde parameters en parameter klassifikasie data dui aan dat sekere parameters soos ouderdomsklas en groeitempo op verskillende mainere bereken is deur gebruikers en dat dit lei tot verdere variasie in die berekeninge van die modelle.

Die studie sluit af met ‘n evaluasie van die ses unieke modelle wat gebruik is. Twee hoof gevolgtrekkings wat aangespreek moet word is: (i) Die standardisasie van ‘n model vir all waardasie doeleindes; (ii) Die voorsiening van riglyne vir die standardisasie van model inset parameters.

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ACRONYMS

ANOVA	Analysis of Variance
APV	Adjusted Present Value
CAI	Current Annual Increment
CST	Current Standing Tonnes
CV	Cost Value
DCF	Discounted Cash Flow
EFIEEAF	European Framework for Integrated Environmental and Economic Accounting
for	Forests
EV	Expectation Value
FAS	Financial Accounting Standards
FES	Forestry Economic Services (South Africa)
FV	Fair Value
FVA	Fair Value Accounting
ha	Hectares
HC	Historical Cost
HCA	Historical Cost Accounting
IAS	International Accounting Standard
IASB	International Accounting Standards Board
IASC	International Accounting Standards Committee
IASCF	International Accounting Standards Committee Foundation
ICAEW	Institute of Chartered Accountants of England and Wales
IFRIC	International Financial Reporting Interpretations Committee
IFRS	International Financial Reporting Standard
IRR	Internal Rate of Return
IVSC	International Valuation Standards Council
JSE	Johannesburg Stock Exchange
LSD	Least Significant Difference
MAI	Mean Annual Increment
MDP	Mill Delivered Price

NDSV	Net Discount Salvage Value
NPV	Net Present Value
NSV	Net Standing Value
OAT	One at a Time
OFAT	One Factor at a Time
PWC	PriceWaterhouseCoopers
SI	Sensitivity Index
SV	Standing Value
WACC	Weighted Average Cost of Capital

CHAPTER 1: INTRODUCTION

1.1 General introduction

Forest valuations are required for a range of purposes including property and timber sales, purchases, financial reporting, collateral, capital taxation, insurance or compensation, and forest planning and management (Little et al., 2012; IVSC, 2012). When performing a forest valuation various methods and techniques are available (Bishop, 1999; Askham and Blake, 2003; Herbohn, 2009) and the selection of a valuation method will depend on the reason for valuation, the age of the trees and the availability of market information (Kengen, 1995).The value of the tree crop can either be estimated directly based on the actual market value of the timber (Standing Value estimate) or it can be derived from a discounted or compounded cash flow approach (e.g. Cost Value or Expectation Value) (Ham et al., 2012). The many different reasons and purposes for which the valuation may be required and the variety of methods that may be employed is further complicated by a wide range of factors that influence the market value of forests and as a result, a large variation in values may be evident (Askham and Blake, 2003; Herbohn, 2009).

The International Accounting Standards (IAS), as published by the International Accounting Standards Board (IASB), provides an international benchmark for financial reporting, and subsequently, for valuations performed for financial reporting. The goal of the IASB is to establish conformity within corporate reporting on a global scale, thus enabling the direct comparison of these corporate financial reports between jurisdictions (IASB, 2014). Within forestry the International Accounting Standard 41, “IAS 41 Agriculture” deals with the valuation of biological property for formal financial reporting purposes (IAS 41, 2011). The release of IAS 41 changed agricultural accounting from a domestic issue dealt with by individual countries to a global issue (Herbohn, 2009). One of the reasons for the conception of this standard has been the increasing number of multinational groups and their holdings of shares across national borders, and the need for international comparability in financial reports (Epstein and Mirza, 2003; Bern and Johansson, 2010; Epstein and Jermakowicz, 2010). Other reasons supporting this single set of international rules include promoting competitiveness and the decrease in investment risk resulting in reduced cost of capital for companies (Fuller, 2004; Brown, 2011).

The IAS 41 came into force on January 1, 2003 and introduced a fair value model to agricultural accounting. The previous use of the traditional Historical Cost Accounting (HCA) model for agricultural enterprises had long been a source of contention. Opponents argued that it failed to adequately account for the unique reproductive and natural transformational nature of biological assets (Argilés and Slof, 2001; Fischer and Marsch, 2013) and ignored changes in the market value of farming assets (Fisher et al., 2010). Switching from this historical cost method to the fair value method however, became a topic of much debate with many entities fearing that the departure from the convenient historical cost valuation method would result in serious drawbacks such as the definition of valuation methods for the agricultural sector (Argilés et al., 2009).

IAS 41 requires for instance a standing timber value and only in the absence of a clearly defined market can a discounted cash flow approach be used (IAS 41, 2011). Standing timber measurement for financial reporting purposes is a difficult and time consuming exercise requiring expertise in forestry, valuation techniques and accounting standards. The application of fair value to standing timber requires a considerable degree of judgment. The fair value is very sensitive to small changes in key factors which, in turn imply significant consequences for the reporting of financial statements (PWC, 2011).

In South Africa, all companies listed on the Johannesburg Stock Exchange (JSE) are required to provide International Financial Reporting Standard (IFRS) compliant financial statements (JSE Listings Requirements, 2012). As a result all South African forestry companies listed on the JSE have been required to conform to the rules of IFRS financial reporting since 1 January 2005 (IFRS, 2013). Conformance to reporting rules and guidelines offers investors a common standard, allowing them to evaluate and compare investment alternatives. Institutional investors are becoming increasingly attracted to forestland as an asset class (PWC, 2011, IVSC, 2012) due to strong historical returns, a low correlation with stocks and bonds, protection from inflation, and the renewable nature of the asset. Subsequently, the amount of investor capital placed in timberland has grown rapidly to USD 70-85bn worldwide in 2010 (Dasos Capital, 2010). Timber investment company BTG Pactual (who manage more than US$3 billion in timberland assets) have for instance recently collected US$860 million from investors for a new timberland fund based across Latin America (BTG Pactual, 2015).

Wood-based biomass is seen as a vital renewable energy resource and therefore offers the possibility of an alternative and sustainable long-term investment strategy having favourable diversification and inflation hedge characteristics (PWC, 2011; Wagnière, 2011). It seems however that despite conformance to financial reporting rules, the IAS 41 allows flexibility in interpretation, raising major questions amongst forestry owners and investors as to how the standard is being applied to forest assets (Bierfreund and Pichlo, 2013).

1.2 Study rationale

The reliability of financial information resulting from the application of IAS 41 has been questioned in a number of studies (Booth and Walker, 2001; Elad, 2004; Herbohn and Herbohn, 2006; Herbohn, 2006; Herbohn 2009). The IAS 41 framework broadly enforces fair value valuation methodology for the purpose of formal financial reporting. Those opposing the relevance of Fair Value Accounting (FVA) are, however, concerned that there is frequently too much uncertainty regarding the ultimate realisation of many agricultural revenues (Herbohn, 2006; Herbohn, 2009). The standard could present a variety of valuation methods for biological assets that could lead to unrealised gains and losses to the income statement (Herbohn and Herbohn, 2006; Herbohn, 2009).

Allowing recognition of different valuation estimates in income statements could result in significant adjustments in subsequent periods and may create pressure on companies to declare and pay dividends for which no funds are available (Herbohn, 2005, as cited in Fisher et al., 2010). Also in South Africa where the fair value adjustment of biological assets is part of income statements (see for instance annual reports of York (2014) and SAFCOL (2013)) this could allow companies to adjust financial accounts depending on whether they wish to show higher or lower earnings (Herbohn, 2006). Manipulation of changes in fair value could be a potential reason why there was a significant increase in the coefficient of variation associated with the reported earnings of sampled companies after the introduction of FVA for biological assets in Australia (Herbohn, 2006).

1.3 Study objective

The application of IAS 41 Agriculture within Forestry could allow those operating within the parameters defined by the requirements of the IFRS some degree of freedom to change the fair value of their standing timber and of disclosing information on significant assumptions (PWC, 2011). It is possible that the lack of stringent and clearly defined methodology within the IAS 41 framework could allow manipulation of FVA to serve the interests of the valuating entity (Herbohn, 2005; Herbohn, 2006; Herbohn, 2009).

In light of this, this study will focus primarily on answering the following question:

What is the possible valuation variance within the IAS 41 framework?

To be able to evaluate and answer this question, the following sub questions are formulated:

- *What methods and models are sanctioned by this framework?*
- *What is the effect on the outputs of the models run on a common input data set when certain variables are changed?*
- *What are the variables that impact on the valuation?*
- *What is the sensitivity of these variables and models?*

1.4 Proposed methodology

This study applied the following activities to address the research question:

- A literature review of the IAS 41 framework was undertaken with reference to the effectiveness of the IAS 41 framework and its implementation.
- Interviews with key informants amongst other experienced South African forest valuers were conducted to gain a better understanding of the problem and to determine the various methods, parameters and aspects related to IAS 41 that are used by various forestry companies and valuers.
- Testing of IAS 41 compliant valuation models was undertaken from both published literature as well as those actively being used by forest valuers, consultants and forestry companies on a case study plantation.

- Analysis and comparison of outputs from these various models on the case study plantation was undertaken.
- Sensitivity analysis and testing of various IAS compliant model parameters was carried out to determine the effect of changes in input variables to the model outputs.

The scope of this study specifically covers financial valuation methods that are permissible within the IAS 41 framework. Data and services required to complete this analysis were obtained from forestry companies and valuers within South Africa. This study focused upon the valuation of pulpwood plantations and does not consider the value of the land.

CHAPTER 2: BACKGROUND INFORMATION

2.1 Introduction

Financial reports are an important means by which companies convey financial and other information about their operations to investors, shareholders and other interested parties. In South Africa all companies listed on the JSE have been required to conform to the rules of IFRS financial reporting since 1 January 2005 (IFRS, 2013).

The content and form of external financial reports regulated by accounting standards were previously the domain of national governments and accounting organizations within a particular country (Herbohn and Herbohn, 2006; Herbohn, 2009). The globalisation of capital markets commencing in the 1960s and 1970s however, led to the need for international financial reporting practices to be 'harmonised' (Henderson et al., 2006). The increasing number of multinational groups and their holdings of shares in different countries, and the need for a set of common standards to increase the comparability of financial reports from different countries trading in the same market encouraged this harmonisation or standardisation (Epstein and Mirza, 2003; Whittington, 2005; Bern and Johansson, 2010; Epstein and Jermakowicz, 2010). Other reasons supporting this standardisation include promoting competitiveness and decreasing investment risk, which may result in reduced cost of capital for companies (Fuller, 2004; Brown, 2011).

The standardisation of accounting standards is driven by the International Accounting Standards Board (IASB) and its predecessor, the International Accounting Standards Committee (IASC). Between 1973 and 2000 the IASC released a series of International Accounting Standards in a numerical sequence that began with IAS 1 and ended with IAS 41 Agriculture. Listed companies and sometimes unlisted companies are required to use the standards in their financial statements in those countries which have adopted the standards (ICAEW, 2012).

Despite being an integral part of natural resource based businesses, accounting for agricultural activities had seldom been a focus of attention for accounting researchers, practitioners and regulators until the approval of International Accounting Standard 41 Agriculture (IAS 41) in December 2000 by the IASC (Argilés and Slof, 2001, Herbohn, 2005). The introduction of IAS 41 was a landmark in financial reporting for agricultural producers and it forced a radical departure from the traditional historical cost accounting method used to value biological assets. It was also an early test of fair value accounting (FVA) (Elad and Herbohn, 2011).

The introduction of the IAS 41 standard has been controversial, with the IASC facing strong opposition from industry, practitioners, and many national professional accounting bodies (Elad, 2004; Fahnestock and Bostwick, 2011). IAS 41 standard's preference for fair-value-based measurement is consistent with a systematic shift from the traditionally dominant, historical cost accounting (HCA) model. While IAS 41 has been acknowledged as providing a good conceptual framework (Argilés and Slof, 2001) those opposed to it have suggested that the IASC's project has portrayed a dubious triumph of theory over pragmatism (Elad, 2004).

Those opposed believe that FVA comes at the expense of reliability and comprehension, referring to the need to sometimes use somewhat arbitrary market-based values derived from subjective methods (Barlev and Haddad, 2003; Penman, 2007). There are also concerns around the cost and difficulty of the annual revaluation requirements imposed by IAS 41, particularly in less developed countries (Elad, 2004) as well as the effects of increased volatility of reported earnings and the inability of fair value to accurately capture the true economics of the business. Furthermore, concerns were raised regarding the application of FVA to a range of assets, industries and countries. The ability of one measurement system to be all things to all stakeholders, with many of the key requirements being tailored to assets where active markets are prevalent was also questioned (e.g., financial instruments) (Penman, 2007). It has been argued, that fair value does not always reflect the true economics of business (Fisher et al., 2010).

Those in favour of FVA point out the enhanced usefulness for decision-making and the transparency of fair value information due to its timely reflection of current market conditions (Laux and Leuz, 2009; Fisher et al., 2010). IAS 41 can be considered an important standard because it represents the starting point of a consistent transition from the purchase cost principle towards a fair value accounting system (Lefter and Roman, 2007). According to Barlev and Haddad (2003) fair value accounting provides full disclosure and is therefore compatible with transparency while Argilés et al. (2009) argues that fair value entails a more consistent valuation method, as well as a more reliable and comparable source of information, thus fulfilling the two primary criteria required by accounting standards, relevance and reliability. In summary it can be argued that the IAS brings many improvements including transparency and comparability into biological asset reporting (Argilés et al., 2009; Argilés et al., 2011).

2.2 The IAS 41 framework

IAS 41 established a single accounting standard for forest assets. The objective of IAS 41 is to prescribe the accounting treatment and disclosures related to agricultural activity. In the context of timber plantations it prescribes how the value of the growing trees should be considered taking into account the rate of growth, the growing period, the age, the degree of degeneration or damage from pests and diseases, harvesting and any other aspects that impact, either negatively or positively on the value of the trees as a biological asset (IFRS, 2013). It does not apply to the land on which the crop is located, and therefore requires that standing timber and forest land should be valued and recorded separately. The value of land is recorded under IAS 16 “Property” (IAS 41, 2011).

IAS 41 defines “Fair Value” as “the amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arms-length transaction” (IAS 41, 2011). In principle, the standard prescribes that biological assets are measured at fair value and that changes in fair value of biological assets during a period are reported as a net profit or loss. Publicly quoted enterprises have to evaluate their biological assets on initial recognition and at each balance sheet date based on the ‘fair value’ according to market prices, from which the cost of activities to effect the sales has been deducted (Argilés and Slof, 2001; Herbohn, 2009). This fair value can be calculated based on the market prices at the time of harvesting after subtracting expenses associated with the harvesting, transport, sale and marketing of the products (Penttinen et al., 2004). This presumes that the fair value of standing timber can be reliably determined, such as in the case of a mature stand of trees which is ready for harvesting.

Determining the market value of young plantings, pre-merchantable and/or middle aged stands requires other methods of valuation. In the absence of a market value the present value of the expected net cash flow from the asset may be used (IFRIC, 2003). The standard also allows entities to use a cost-based model (historic cost accounting) if, on initial recognition of a biological asset, it is not possible to reliably determine the fair value (Elad and Herbohn, 2011). In order to simplify the practical application of the Standard, the following hierarchy of approaches is prescribed by it (IAS41, 2011):

(i) Comparable sales.
(ii) Expectation approach.
(iii) Cost-based approach.

2.2.1 Comparable sales

The first step in fair value determination is to check the existence of an active market for the biological asset. If an active market exists then the quoted price in an active market for the biological asset or biological produce is the appropriate basis for determining fair value. In the context of IAS 41 (2011), an active market is defined as a market where all of the following conditions exist:

(i) The items traded within the market are homogeneous.
(ii) Willing buyers and sellers can normally be found at any time.
(iii) Prices are available to the public.

2.2.2 Expectation approach

Second, if an active market does not exist an entity should consider using one or more of the following when available, in determining fair value (IAS 41, 2011):

(i) The most recent market transaction price, provided that there has not been a significant change in economic circumstances between the date of that transaction and the balance sheet date.
(ii) Market prices for similar assets with adjustment to reflect differences, and
(iii) Sector benchmarks such as the value of an orchard expressed per export tray, bushel, or hectare and the value of cattle expressed per kilogram of meat, or in the case of a pulpwood plantation the value of timber expressed per tonne of pulpwood (Avery and Burkhart, 2002).

If market determined prices for the biological assets in their present condition are not available in the market, the entity should consider the present value of the expected net cash flows from the assets in determining the fair value (IAS 41, 2011). The objective of a calculation of the present value of expected net cash flows is to determine the fair value of a biological asset in its present location and condition. Where markets for standing timber are limited and/or where there are few comparable sales of pulpwood plantations, the expected cash flow method should be applied for assessment of standing timber (IAS 41, 2011).

2.2.3 Cost-based approach

Thirdly, if market-determined prices or values are not available and alternative estimates of fair value are determined to be clearly unreliable, the biological asset should be measured at its cost less any accumulated depreciation. This option should only be applied if little biological transformation has taken place since the initial cost was incurred and the impact of the biological transformation on price is immaterial (IAS 41 2011). IAS 41 lists fruit tree seedlings planted immediately prior to a balance sheet date, and initial growth in a 30-year pine plantation production cycle as examples. If the market value is unavailable and the net cash flows from the biological assets are difficult to estimate, this method may be applied.

In summary, the process of determining which approach to use is as follows (Thurrun-Bhakir, 2010; Bierfreund and Pichlo, 2013) (Figure 2.1):

- Given that fair value can be measured reliably, the value should firstly be based on quoted prices in an active market.
- If no such market exists, the valuer should use other market-determined prices such as recent transaction prices, prices of similar assets or sector benchmarks.
- If there are no market-determined prices available, the entity should determine fair value using a discounted cash flow (DCF) model
- Finally, should none of the above be available, the cost based approach should be considered.

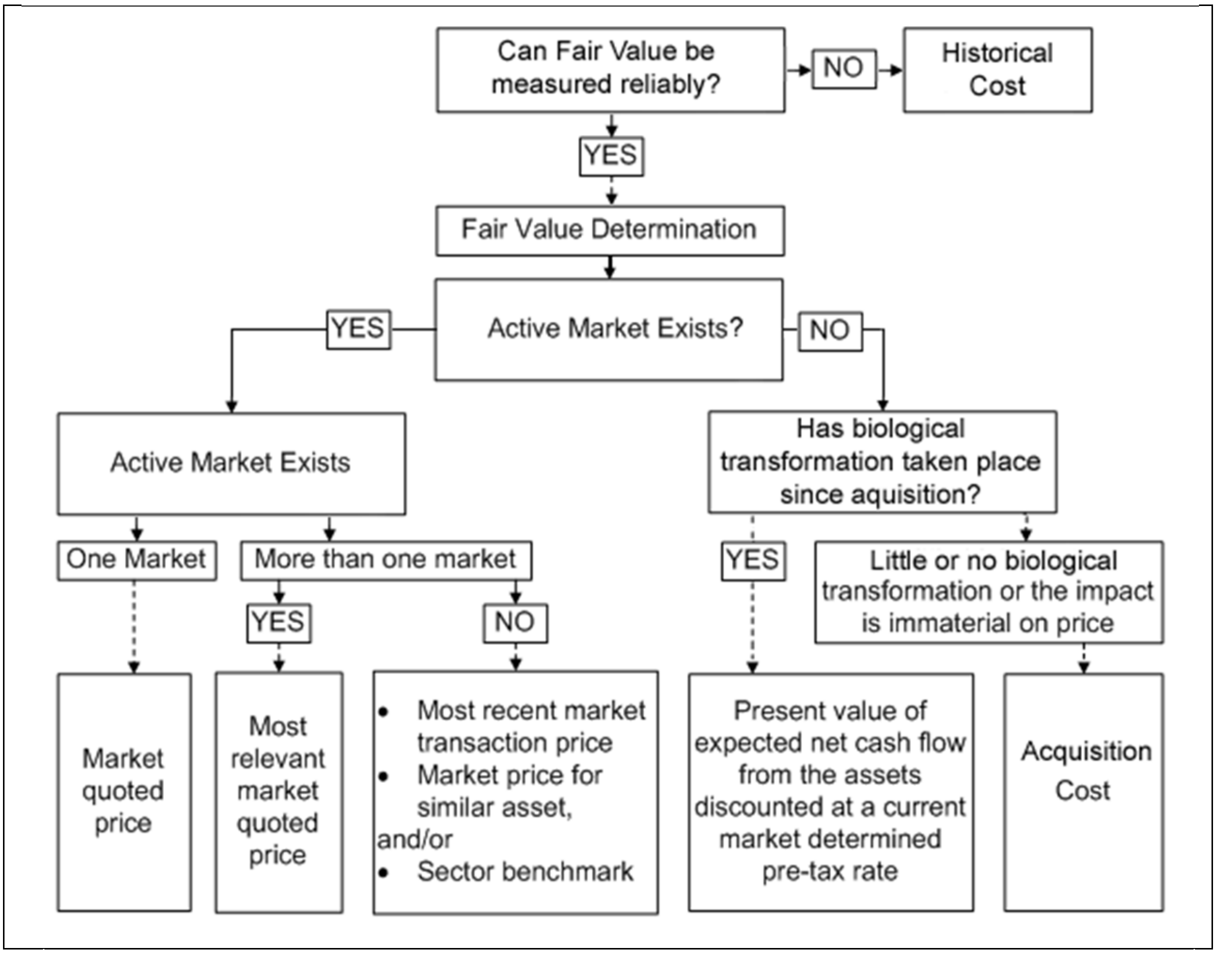


Figure 2.1: Selection of an appropriate valuation method (adapted from: Thurrun-Bhakir, 2010; Bierfreund and Pichlo, 2013).

2.3 Application of IAS 41 framework in forestry

Surveys amongst international forestry companies (19 companies in 2009 and 25 companies in 2011) indicated that Net Present Value (NPV) arrived at by Discounted Cash Flow (DCF) modelling was by far the most common method of determining the fair value of forestry assets (PWC 2009; PWC 2011). Bern and Johansson (2010) and Bierfreund and Pichlo (2013) also confirmed that the DCF method is the most common method for valuation used by international companies, an observation supported by the annual financial reports of SAFCOL, SAPPI, Mondi and YORK in South Africa (SAFCOL, 2013; SAPPI, 2013; York, 2014; Mondi, 2014). The reason for the extensive use of the DCF approach may be due to the possibility of controlling the valuation in the financial statements to a certain degree by adjusting the input variables (Bierfreund and Pichlo, 2013).

2.4 Practical problems with timber valuations

Within the above mentioned valuation framework the valuation method, input parameters and assumptions can differ substantially. The selection of the correct valuation method was already recognised as one of the most significant valuation problems in South Africa in the 1940's (O'Connor, 1941; Uys, 1997). In principle comparable sales is the best valuation method when data is available. However for forests to be truly comparable they need to be in the same time period and have the same site quality, size, timber species, age class composition, timber quality, market and access to markets. Such similarities do not occur often and an average price may thus not be a good estimate of market value (Klemperer, 1996).

Without access to reliable market prices, the valuer is required to apply valuation techniques and make judgment calls regarding for example, selling prices, costs and discount rates (PWC, 2011). Furthermore the valuation of a biological asset (trees in a forest) can change due to both physical changes (forestry is exposed to climatic, disease and other natural risks) and price changes in the market.

Marwick (1973) emphasises the complexity of forest valuation by highlighting the number of possible variables that have to be considered. These variables include amongst others:

- Species
- Age
- Planting espacement
- Average tree height
- Average diameter at breast height
- Generation (plant, 1st coppice, 2nd coppice)
- Stems per hectare
- Bounding area
- Merchantable volume
- Silvicultural treatment (including thinning/pruning)

- Intended length of rotation
- Intended end product (sawlogs, pulp)
- Conversion factor, yield table (volumes)
- Revenue (price lists)
- Expenditure (indirect expenses, roads, buildings, fences)
- Direct expenses (establishment, maintenance).

The difficulty of timber valuation is further compounded by the potential significance that each of the input parameters has on the final valuation. Marwick (1993) rightfully indicated that plantation value can be accurately determined at two points within its rotation, namely:

- At the time of establishment where the cost of establishment is used at time of planting, and
- At the time of clearfelling where the value is based on the log volume yield, log class distribution and stumpage prices.

Performing a valuation at any time between these two points in time is a more difficult task and requires a careful and justifiable selection of the right valuation method.

2.5. Forestry valuation methods

While the DCF valuation approach seems to be preferred by most forestry companies, a variety of IAS 41 compliant forestry valuation methods exist, and are used for valuation purposes within the forestry sector, including:

- Standing value method
- Cost value or Faustmann method
- Discounted cash flow methods
- Historical cost method.

2.5.1 Standing value method

The standing value (SV) method is based on the availability of an active market for timber where the quoted price in the market is used to determine a fair value for the tree crop (Kamaruzzaman and Erlane, 2013). The SV, also known as stumpage value or liquidation value (Bullard and Straka, 2011) is the value of standing marketable timber at the age when the value is required (Uys and Daugherty, 2000). It can be determined through an inventory and using the market price of timber (Ham et al., 2012). While there may be an active market or trees present, timber from young or very old trees could be excluded from this market due to it not being suitable. SV would thus be an unrealistic valuation method. This is because after a stand is established and for a few years thereafter, a stand does not contain any merchantable timber and therefore has no SV (Ham et. al, 2012). While the SV seems a simple function of volume and market price, it can be affected by the following elements (adapted from Davis et al., 2001; Nunamaker et al., 2007; IVSC, 2012):

- Volume of timber, which is determined by and dependent upon:
  - The accuracy of estimated stand area.
  - Enumeration data for the current standing tree crop (to determine the volume per hectare).
  - In the absence of current enumeration data, average growth per year or Mean Annual Increment (MAI) at fell age, determined on a site specific basis as per enumeration data, and used in the estimation of standing volume.
  - Accuracy of planting dates and ages which directly influence the estimation of standing volume.
- Pricing, which is determined by and dependent upon:
  - Point of timber sales (e.g. at stump, roadside or mill).
  - Transport costs to point of sale.
  - Different species, products and markets such as saw-timber, poles, pulp or mining timber.
  - Harvesting costs of timber if not sold on stump.

The use of the SV method for the valuation of forests is well documented within forestry textbooks and journals (Davis et al., 2001; Nunamaker et al., 2007; Ham et al., 2012; IVSC, 2012). The stumpage or SV method appears to fit the requirements of IAS 41 where the forest that is being valued can yield merchantable timber, where a current active market exists and where current market prices and costs are available (IAS 41, 2011). However, its utility is limited where forests are dominated by un-merchantable timber stands (Ham et al., 2012).

2.5.2 Cost value method

The Faustmann formula was developed by a German forester, Martin Faustmann, in 1849 to calculate the bare land price that would allow a return from forests established on that land at a specified rate of interest (Marwick, 1993). Faustmann's formula specifically considered a perpetual investment in forests. The cost value (CV) formula, a variation of the Faustmann formula, derived by Matthews (1935), can be used to compute the cost value of a financially immature plantation. This CV formula is equal to the expectation value at all points when internal rate of return is used in the calculation (Ham et al., 2012). This is the generally accepted valuation method used in South African forestry (Uys, 1997). It is the result of compounding input costs, such as establishment and maintenance at the internal rate of return associated with the plantation cash flow being considered. By discounting the expected future net revenue at clear fell age and the expected annual maintenance costs, by the associated internal rate of return the expectation value is achieved. The internal rate of return is the unique interest rate at which the compounded net cash flows coincide with the discounted net cash flows (Marwick, 1993), and is defined by Bettinger et al. (2009) as the discount rate that is required to arrive at a NPV of zero.

The merits of using the CV method have been tested in the Supreme Court in the matter HILL vs. MERCROWE FORESTRY (Case no. I 1015/77 delivered 30 May 1979) in which it was stated that the ultimate test of value is what the plantation would realise by a comparable sale on the open market. Mr Justice Friedman found that in the event that a good comparable sale was not available, the application of the CV (or Expectation Value (EV)) was an acceptable alternative, being widely used in practice as guides for the sale of plantations, insurance and compensation (Uys and Daugherty, 2000).

2.5.3 Discounted cash flow methods

Variations of the Discounted Cash Flow (DCF) method are frequently used by the forestry sector, due to differences in the timing of income from forests and the timing of costs incurred in the cultivation, maintenance and protection of the crop (IVSC, 2012). It is also a well-established valuation method within the field of corporate finance, where it is used to estimate the attractiveness of an investment opportunity (Senanayake, 2010; O'Keefe et al., 2010). DCF analysis uses future free cash flow projections and discounts them, most often using the weighted average cost of capital (WACC), to arrive at a present value. If the value arrived at through DCF analysis is higher than the current cost of the investment, the opportunity may be acceptable (Senanayake, 2010; O'Keefe et al., 2010). DCF methods are based on the concept that the value of a company may be determined by considering its future profitability and cash flows (Häcker and Ernst, 2011).

Using the DCF method to determine the fair value of biological assets has raised concerns because of the assumptions used. These would likely vary between companies and between countries (Kamaruzzaman and Erlane, 2013) and therefore the method is inherently subjective and may provide opportunities for manipulation (Dvorakova, 2006; Thurrun-Bakir, 2010).

Another issue raised regarding the use of the DCF method is the selection of different discount rates used in the calculation of the present value of future net cash flows. The discount rate normally used is either pre-tax discount rate, pre-tax weighted average cost of capital or current market determined post-tax discount rate. Depending on the valuation method chosen, different discount rates have to be applied. Here it is necessary to ensure that the discount rate is consistent with the valuation method and with the definition of the cash flows to be discounted (Häcker and Ernst, 2011). Again, different discount rates used by different companies and geographical regions have raised concerns regarding the comparability and verifiability of financial statements among companies and countries (Dvorakova, 2006; Aryanto, 2010; Thurrun-Bakir, 2010). Therefore it can be argued that the fair value determined by the DCF method may not reflect the true fair value of the biological assets (Kamaruzzaman and Erlane, 2013).

2.5.4 Historical Cost

IAS 41 acknowledges that cost may be the best indicator of fair value where limited biological transformation has taken place, such as in the case of newly planted seedlings (Marwick 1993). It can be argued that the use of the historical cost method is reliable and cheap, but in some cases it may have little relevance for making economic decisions. In most cases the current value methods are more relevant, but also less reliable since they involve subjective judgements relating to input variables (Svenson et al., 2008).

The historical cost approach for tangible assets gives guidance on the application of the cost approach to real property and these principles can be applied to forests. It provides an indication of value by calculating the current replacement cost of an asset and making deductions for physical deterioration and all other relevant forms of obsolescence. It is based on the principle of substitution, i.e. that unless undue time, inconvenience, risk or other factors are involved, the price that a buyer in the market would pay for the asset being valued would not be more than the cost to assemble or construct an equivalent asset (IVSC, 2012).

The historical cost approach is most applicable to recently planted forests, where the cost of creating an equivalent asset may be able to be judged with a reasonable degree of certainty. In the case of young trees, buyers and sellers are likely to give more weight to the current cost of planting on the valuation date and the opportunity cost of the time required for a new plant to grow to the age of plants under consideration, than to the expected cash flow on harvest. Typical costs that would be considered include (IVSC, 2012):

- The cost of acquiring suitable land for planting (assuming the interest being valued includes land).
- The cost of infrastructure.
- The cost of cultivation and preparation.
- The cost of buying, planting and establishing the young trees.
- Any unrecoverable taxes that would be incurred in creating the above.

The historical cost approach is generally less applicable to established forests because it is more difficult to establish the cost of an equivalent forest and may not even be possible to create an equivalent forest because of the time required for the tree crop to reach the same stage of maturity (IVSC, 2012).

2.6 Practical problems within IAS 41

While there are several models to determine fair value as discussed previously, the use of different assessment models leads to differences of earnings quality in the agricultural sector internationally (Elad and Herbohn, 2011). The use of the fair value methodology as prescribed by IAS 41 is not likely to generate comparable valuations between forest owners due to the latitude it allows for individual preparers to determine what fair value is relative to their business (Bigsby, 2004). IAS 41 does not prescribe a valuation method. Each preparer must determine the valuation approach which is most representative for its standing timber (PWC, 2011).

The requirement to calculate fair value of forestry assets that have no market value may encourage plantation companies to value their biological assets based on assumptions which could be subjected to manipulation (Kamaruzzaman and Erlane, 2013). This could jeopardise the comparability and verifiability of financial information, thereby affecting the good corporate governance practices among plantation companies. This argument is consistent with studies that highlight the concern of financial statement preparers regarding the reliability of income recognition under fair value measurement of biological asset due to the lack of active markets, particularly in the plantation and forestry sectors (Elad and Herbohn, 2011). Such concerns may reduce over time when the financial statement preparers fully understand the concept of IAS 41 Agriculture (Fisher et al. 2010).

The IASB has recognised that sometimes it is simply not possible to obtain a reliable measure of fair value. Therefore, IAS 41 includes a “reliability exception” to the fundamental fair value measurement principle. This “reliability exception” places the burden of judgement on the preparer and auditor of the financial statements and is an illustration of the trade-off between relevance and reliability (Alfredson et al., 2007).

The choice of a valuation method and its underlying assumptions and inputs could thus have a material effect on the profitability of a forestry company. The principal concern is when active markets for biological assets do not exist. In such instances reporting entities may have to estimate fair values by determining the NPV of future cash flows. This would yield inherently subjective valuations based on the discount rate and growth projections used (Dowling and Godfrey, 2001).

2.7 Conclusion

This chapter presented a background on IAS as well as the IAS 41. It has been established that there are concerns regarding the implementation of IAS 41, one of which is the numerous variables required within valuation methods. The background and explanation of some of the valuation methods currently in use was discussed, as were the more prevalent variables within these methods. The effect of different valuation methods, their underlying assumption and input data will be investigated in more detail within this study. The next chapter will present the methodology followed within this study.

CHAPTER 3: METHODOLOGY

3.1 Background

The IAS 41 framework allows the use of different valuation methods within prescribed limits. Different valuation methods, their different underlying assumptions and input data could, however, allow variation in valuation results. To test the rigidity of the IAS 41 framework the study focussed on testing different valuation methods on the same underlying data from a case study plantation. This could also possibly highlight potential areas where variances are likely to occur, as well as the magnitude of these potential variances within the framework. Explorative research was performed in order to achieve this goal. The purpose of this is to gain insight into a situation or phenomenon, especially where little previous research information is available (Bless and Higson-Smith, 1995). The explorative research design component allowed an open and flexible research strategy which included methods such as literature reviews and interviews to gain insight and comprehension (Babbie and Mouton, 2001).

The research process was as follows:

- Background study and key informant survey.
- Model construction and comparison on case study plantation.
- Sensitivity analysis.

3.2 Background study and key informant survey

3.2.1 Source of information

Primary data was gathered for the purpose of this study through key informant interviews (Goetz and LeCompte, 1984) with valuation experts active within the South African forestry industry (Novikov and Novikov, 2013). The study targeted those performing standing timber valuations within the South African forestry sector, specifically those who performed these valuations for the purpose of financial reporting. Interviewees who were ultimately selected had to meet the following criterion:

- Consent to participate.
- Active within the industry.
- Familiar with IAS 41 and its requirements.
- Perform IFRS compliant valuations.

Experts were consulted regarding the valuation models they use. Qualitative data was collected from these interviews to validate variables and to obtain information on knowledge, attitudes and perceptions (Berg, 1989) with regards to how these models were constructed and implemented.

3.2.2 Valuer survey

Primary contact to potential key informants was made through email correspondence and telephonic conversations, to find interviewees who were both capable to provide valuation models with relevant specifications, and who were willing to participate in the study. These informants were asked about other valuers who could contribute to the study. This snow ball enquiry process (Babbie and Mouton, 2001) made it possible to identify seven key informants in the South African forestry industry who could contribute meaningfully to the study. A total of fifteen interviews were conducted with the seven key informants with the aim of accurately acquiring valuation models used within the SA forestry industry and gaining an understanding of the logic behind these models.

An interview can be held without direct contact such as over the telephone (Bless and Higson-Smith, 1995) but conducting interviews in person is preferable, as telephonic interviews could have a negative effect on the interview result. Because of this all of the interviews performed for this study were done in person. Face to face interviews facilitate probing of responses to investigate and ensure that each participant gave full answers (Marvasti, 2004). Interviews give the possibility of asking attendant questions and directing the conversation into other areas of concern that may arise (Robson, 2002).

The objective of the key informant interviews was to understand the valuation models used by interviewees. Interviews where thus not guided by a questionnaire but based on interviewees explaining the mechanics and variables of the valuation models used by them in detail. In most cases these models were received at or subsequent to the interview in electronic format (Microsoft Excel spread sheets). Where this was not possible the logic discussed within these interviews was used to rebuild the model within an Excel spreadsheet. When complete, this Excel spreadsheet was returned to the interviewee for confirmation that it was indeed representative of the original model. When necessary follow up interviews were performed to iron out any flaws in the logic of these models (Kumar, 1989).

Based on the key informant interviews five unique valuation models were developed for further testing on the case study plantation.

3.3 Model construction and comparison on case study plantation

3.3.1 Case study plantation

3.3.1.1 Compartment attribute data

A set of plantation data was sourced to be used as input into each valuation model. The plantation used for this model lies within KwaZulu-Natal, and the data was obtained from an undisclosed forestry company. This set of plantation data is included in Appendix 1. A valuation had previously been done by a valuation consultant on this plantation and some of the inputs into the models were sourced from this valuation, including compartment yields and yield classes, as well as land values.
This plantation consisted of 148 compartments of differing genera (Eucalypt, Pine and Wattle) across all age classes and a range of site qualities (Table 3.1). The total area of this plantation is 1,430.3 ha.

Table 3.1: Input plantation area (hectares) per age class

Age Class	Hectares			
	Eucalypt	**Pine**	**Wattle**	**Total**
1	24			24
2	65.3			65.3
3	200.1	7.2		207.3
4	213.3			213.3
5	169.9	29.5		199.4
6	55.2			55.2
7	59.3		20.5	79.8
8	122.2	2.4		124.6
9	58.4	120.8	82.3	261.5
10		33.4	10.1	43.5
11			93.8	93.8
13		3.6		3.6
14		41.5		41.5
15		14.6		14.6
16		2.9		2.9
Grand Total	967.7	255.9	206.7	1,430.30

The planned clearfelling ages per genus indicated in the management plan for this plantation are 10 years for eucalypt, 11 years for wattle and 16 years for pine. The compartment data contains a yield class field, where Eucalypt yield classes range from G.1 through to G.7, pine yield classes range from P.1 through to P.5 and wattle yield classes range from W.1 through to W.4. Lower numbers denote higher yield classes.

The yield class is defined in Hemery and Simblet (2014) as the standard forestry expression of growth rate in terms of maximum mean annual increment per year, expressed as cubic meters per hectare per year. Within the scope of this study the yield has been calculated from the expected yield (in tonnes) per hectare at the compartment fell age. By dividing this expected yield (in tonnes) per hectare at fell age by the relevant fell ages, the mean annual increment in tonnes (MAI(t)) was calculated (Table 3.2).

Table 3.2: Yield classes per genus (tonnes/ha)

Genus	Fell Age (Years)	Yield Class	Expected yield (tonnes of pulp) per ha at fell age	Expected yield (tonnes of bark) per ha at fell age	MAI(t) (tonnes of pulp and bark / fell age) per hectare	Utilisable Age
Eucalypt	10	G.1	240		24	1.5
		G.2	210		21	1.5
		G.3	180		18	1.5
		G.4	160		16	1.5
		G.5	140		14	1.5
		G.6	120		12	1.5
		G.7	100		10	1.5
Pine	16	P.1	440		27.5	2.5
		P.2	400		25	2.5
		P.3	350		21.88	3
		P.4	270		16.88	3
		P.5	220		13.75	3
Wattle	11	W.1	150	27	16.09	2
		W.2	122	22	13.09	2
		W.3	110	20	11.82	2
		W.4	88	16	9.45	2

MAI(t) was used to calculate the standing tonnes of each compartment as illustrated by the following example:

- A 2.5 ha compartment of six year old eucalypt with yield class G.1, had the following expected yield:

  Expected tonnes = 2.5(ha) x 6(age) x 24(MAI(t)) = 360 tonnes.

The utilisable age calculated per yield class (Table 3.2) is the age at which a yield class is determined to produce utilisable volume. Therefore, a 1.9 year old compartment of wattle will have zero utilisable tonnes. The determination of the utilisable age has been based upon a 5 cm minimum diameter threshold for pulpwood (Kotze, 2015).

3.3.1.2 Financial data

It is important to use the same inputs into each valuation model, to ensure that only the behaviour of the model is responsible for the possible variation in output. Cost and sale price data for the case study plantation for 2012 was acquired from Forestry Economic Services (FES) for KwaZulu-Natal Province (Meyer, 2012) and used as the model input data. The data was used in the construction of standard silvicultural regimes for the three genere which make up the case study plantation (Table 3.3). Annual recurring expenses were also defined and are presented in Table 3.4.

Table 3.3: Regime and costs per genus per hectare adapted from Meyer (2012)

	Eucalypt/ ha	**Pine/ ha**	**Wattle/ ha**
Year 0: Establishment	R 4,664.79	R 5,411.93	R 5,031.89
Year 1: Weeding 1st year (3 operations)	R 1,396.65	R 1,758.48	R 1,656.27
Year 2: Weeding 2nd year (1 operation)	R 465.55		
Year 2: Weeding 2nd year (2 operations)		R 1,172.32	R 1,104.18
Year 3: Weeding 3rd year (1 operation)		R 586.16	
Year 3: Corrective pruning in 3rd year			R 319.90
Year 4: Spacing 4th year			R 594.12
Year 5: Pruning to 2 meters in 5th year		R 581.78	
Year 8: Brashing in 8th year	R 391.97		

Table 3.4: Annual recurring expenses per hectare adapted from Meyer (2012)

	Eucalypt/ ha	**Pine/ ha**	**Wattle/ ha**
Forest protection and conservation			
Pests and noxious weed control	R 82.39	R 82.39	R 82.39
Wattle bagworm and mirids	R 0.00	R 0.00	R 30.69
Fire protection	R 296.83	R 296.83	R 296.83
Fire fighting	R 140.79	R 140.79	R 140.79
Conservation	R 64.98	R 64.98	R 64.98
Annual overhead costs per afforested hectare			
Hand Tools	R 4.83	R 4.83	R 4.83
Road Maintenance	R 107.09	R 107.09	R 107.09
Building Maintenance	R 29.92	R 29.92	R 29.92
Maintenance of other improvements	R 19.90	R 19.90	R 19.90
Administration	R 855.51	R 855.51	R 855.51
Community Development	R 52.43	R 52.43	R 52.43
Total	R 1,654.67	R 1,654.67	R 1,685.36

The standing value of timber per tonne for the case study plantation was calculated by subtracting the harvesting and transport costs from the Mill Delivered Price (MDP), all sourced from Forestry Economics Services (Meyer, 2012) (Table 3.5) to obtain a Rand (R) value per tonne of utilisable pulpwood/bark. The wattle bark to pulp wood ratio used within the previous commercial valuation of the case study plantation was used for this study (1:5.5). Using this ratio, it can be calculated that a tonne of wattle consisting of 846kg pulpwood @ R 334.76/tonne, and 154kg bark @ R373.78/tonne, has a resulting net wattle value of R 340.71/tonne.

Table 3.5: Standing value per tonne from FES data (Meyer, 2012)

	Standing value per tonne for pulpwood and bark				
	Eucalypt pulpwood	**Pine pulpwood**	**Wattle pulpwood**	**Wattle bark**	**Wattle total**
Delivered to buyer	R 463.80	R 263.50	R 630.32	R 913.82	R 673.57
Minus transport	- R 139.58	- R 79.12	- R 188.05	- R 208.31	- R 191.14
Minus harvesting	- R 87.90	- R 87.71	- R 107.51	- R 331.73	- R 141.71
Standing value (R/tonne)	R 236.32	R 96.67	R 334.76	R 373.78	R 340.71

A default value of R14,000.00/ha was used for land value based on Forestry Economic Services data for KwaZulu-Natal in 2012 (Meyer, 2012).

3.3.1.3 Interest rates

Meyer (2012) presents the following nominal interest rates for forestry activities in KwaZulu-Natal in 2012:

- Eucalypt projects: 15.1%
- Pine projects: 14.1%
- Wattle projects: 10.7%

Most interviewees made use of a single interest rate when performing valuations (catering for valuations of compartments of all genre). Following this logic, a single weighted nominal interest rate was calculated by multiplying these interest rates per genus by the hectares within the sample plantation (Table 3.6) to obtain a weighted nominal interest rate of 14.3%.

Table 3.6: Weighted nominal interest rate for case study plantation, adapted from Meyer (2012)

	Eucalypt	**Pine**	**Wattle**	**Total**
FES 2012 Interest Rate (%)	15.1%	14.1%	10.7%	
Area (hectares)	967.70	255.90	206.70	1,430.30
Interest Rate x Area	14,612.27	3,608.19	2,211.69	20,432.15
Weighted Nominal Interest Rate(%)				14.3%

A long term average South African inflation rate of 6.2% was sourced for the 20 year period from 1993 to 2012 (inflation.eu, 2015).

Using these two rates, the real interest rate was calculated using the following equation from Ham and Jacobson (2012):

$$\text{Real rate} = \frac{1 + \text{nominal rate}}{1 + \text{inflation rate}} - 1$$

Equation 3.1: Real Rate (Ham and Jacobson, 2012)

The resulting real rate of 7.6% was used as the default interest rate for the case study plantation.

3.3.1.4 Internal rate of return

The internal rate of return (IRR) is the discount rate at which the NPV of an investment becomes zero. In other words, IRR is the discount rate which equates the present value of the future cash flows of an investment with the initial investment (Bettinger et al., 2009). The default internal rate of return (Table 3.7) was calculated per yield class based on the establishment and maintenance costs from Table 3.3 and the annual recurring costs as tabulated in Table 3.4.

Table 3.7: Internal rate of return (IRR) as calculated per yield class

IRR per yield class (%)			
[1]Class	Eucalypt	Pine	Wattle
1	8.44	1.08	7.14
2	7.05	0.46	5.16
3	5.49	-0.39	4.22
4	4.33	-1.98	2.22
5	3.06	-3.16	-
6	1.65	-	-
7	0.06	-	-

[1] Lower numbers denote better (higher) yield classes

3.3.2 Generating model data

The valuation models from the key informant survey were linked into an Excel workbook as separate spreadsheets, and each fed with the case study plantation data defined in section 3.3.1.1. Each model calculated value for a given set of input parameters by estimating the tonnes per set of input parameters, and multiplied the price per tonne to determine the value per set of input parameters. Model output data, and specifically a rand per hectare (R/ha) value was generated from each model for one hectare (1 ha) for each genus, age class and yield class combination. This resulted in 194 input combinations, made up of 70 eucalypt (yield class 1-7, age classes 1-10), 80 pine (yield class 1-5, age classes 1-16), and 44 wattle (yield class 1-4, age classes1-11) combinations. In total, 18 output valuation tables were generated in this way, one table per model and genus, and included in Appendix 2.

These "value per age and yield class" tables were used to calculate the case study plantation value per model in the following way:

(i) Calculate each case study compartment value by multiplying the relevant (R/ha) value from the corresponding "value per age and yield class" table (described above) by the compartment area.

(ii) Summing the individual compartment values to obtain the total plantation value per model.

3.3.3 Treatment of parameters

3.3.3.1 MAI

Most of the interviewees were found to use a straight line Mean Annual Increment (MAI) when calculating tree volume. MAI is typically calculated by forestry practitioners by dividing the yield from a stand of trees at a particular age, for example at clearfelling age, by the age and area of the stand. The unit is then cubic meters or tonnes per ha per year and the age at which it was calculated should be indicated due to the fact that the MAI varies with age (Avery and Burkhart, 2002). This straight line MAI is then used to estimate the volume of the compartment at any age within the growth cycle. This straight line MAI, as used by most interviewees, was used as a baseline in this study to test the difference between this method, and growth model based methods, on valuation results.

3.3.3.2 Age class

All of the interviewees were found to use some form of age class grouping. Age class grouping involves the grouping of compartments together based on similar ages. Therefore, using the "rounding to the nearest whole number" methodology, a compartment between the ages of 0.5 and 1.4 years old is regarded as belonging to age class 1, and for the purpose of volume calculations, is regarded as being one years old. IAS 41 allows age class grouping, but does not provide guidelines on how this grouping is to be done. As a result all age class grouping methodologies are accepted by IAS 41 (PWC, 2011).

The "rounding to the nearest whole number" methodology used by some of the interviewees, has been used as the baseline methodology in determining the age class within this study. All of the models used within this study have been adjusted to use the same logic for default age class calculation.

3.4 Analysis

3.4.1 Statistical analysis

For all statistical analysis performed within this study, a 5% significance level has been used. All analyses were done with the use of the statistical software programs SAS (SAS Institute, 2011), Statistica version 10.0 (Statsoft, Inc., 2011), and R version 3.11 (R Core Team, 2014).

If the residuals from a repeated measures ANOVA are normally distributed, then repeated measures ANOVA would be the preferred method for analysing differences among the means of models (Krishnaiah, 1981). However it was discovered with the Shapiro-Wilk test (Shapiro and Wilk, 1965) that the residuals were in fact non-normally distributed, therefore a non-parametric test was required.

To test for significant differences in model valuations across the case study compartments, as well as to determine whether model valuation totals were significantly different across the three genera, the Friedman test was used. The Friedman test is a non-parametric statistical test similar to the parametric repeated measures ANOVA, used to detect differences in treatments across multiple test attempts on the same experimental units. The procedure involves ranking each row (or block) together, then considering the values of ranks by columns (Friedman, 1937).

To test for differences among the means of models within the three genera, when the residuals from the repeated measures ANOVA were not normally distributed and samples were sufficiently large, the bootstrap method was used as the preferred multiple comparisons method rather than the Bonferroni multiple comparisons method. The bootstrap method works without needing assumptions like normality, but it can be highly variable when the sample size is small and the residuals are not normal. Bootstrapping is a statistical technique that falls under the broader heading of resampling. Bootstrapping can be used in the estimation of nearly any statistic. It involves a relatively simple procedure, but repeated so many times that bootstrap techniques are heavily dependent upon computer calculations (Hollander and Wolfe, 1973; Varian, 2005).

Where sample sizes were not sufficient for the bootstrap multiple comparisons test, the Wilcoxon signed rank test was used in order to determine whether pairs of models per genera produced significantly different valuations. The Wilcoxon signed-rank test is a non-parametric statistical hypothesis test used to compare two related samples, matched samples, or repeated measurements on a single sample to assess whether their population mean ranks differ (it is a paired difference test) (Lowry, 1999). The p-values determined using the Wilcoxon signed-rank test were then adjusted using Bonferroni correction, a method used to counteract the problem of multiple comparisons (Kaplan, 2015).

3.4.2 Sensitivity analysis

A sensitivity analysis of the output values was performed on the valuation models, based on a change in input parameter values. Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model can be apportioned to different sources of uncertainty in its inputs. Nominal range sensitivity analysis evaluates the effect on model outputs exerted by individually varying only one of the model inputs across its entire range of plausible values, while holding all other inputs at their nominal or base-case values (Cullen and Frey, 1999).

Sensitivity was measured by monitoring changes in the output. A "changing one-factor-at-a-time" (OFAT or OAT) form of the sensitivity analysis was performed to determine what effect this produced on the output (Brun et al., 2006). The difference in the model output due to the change in the input variable is referred to as the sensitivity or swing weight of the model to that particular input variable (Morgan and Henrion, 1990). The sensitivity analysis focussed on the following parameter inputs and their effect on the valuation output:

- Discount Rate
- Interest Rate
- Yield (MAI)
- Age Class Calculation variance (round up, round down, actual age)
- Land Value
- Harvesting and Logistics (Stumpage) Costs
- Market Price.

3.4.2.1 Sensitivity index (SI)

To determine parameter sensitivity a sensitivity index was calculated. This is done by calculating the percentage difference in the output when varying one input parameter from its minimum value to its maximum value. The sensitivity index was introduced by Hoffman and Gardner (1983) to account for all possible values when determining parameter sensitivity.

$$SI = \frac{(D\max - D\min)}{D\max}$$

Equation 3.2: Sensitivity Index (Hoffman and Gardner, 1983)

Where:

SI = Sensitivity index.

Dmax = Output result when the parameter in question is set at its maximum value.

Dmin = Result for the minimum parameter value.

When reporting on the results of a sensitivity analysis, Pannell (1996) recommends a table of sensitivity index values ranked according to their absolute value.

3.5 Conclusion

IAS 41 compliant financial models currently being used within the industry were collected through key informant interviews with valuation experts in the South African forestry industry. These models were then run on input data from a case study plantation to produce outputs which were statistically analysed. From the results of the overall process, it is possible to obtain an understanding of the potential degree of variance that exists between the results of models run for the same purpose, and using the same set of source data as input.

CHAPTER 4: RESULTS

4.1 Introduction

The sequence of activities as described in chapter 3 allowed the identification and testing of six unique valuation methods generally used in South Africa on the same case study plantations. The research process flow is summarised below in Figure 4.1.

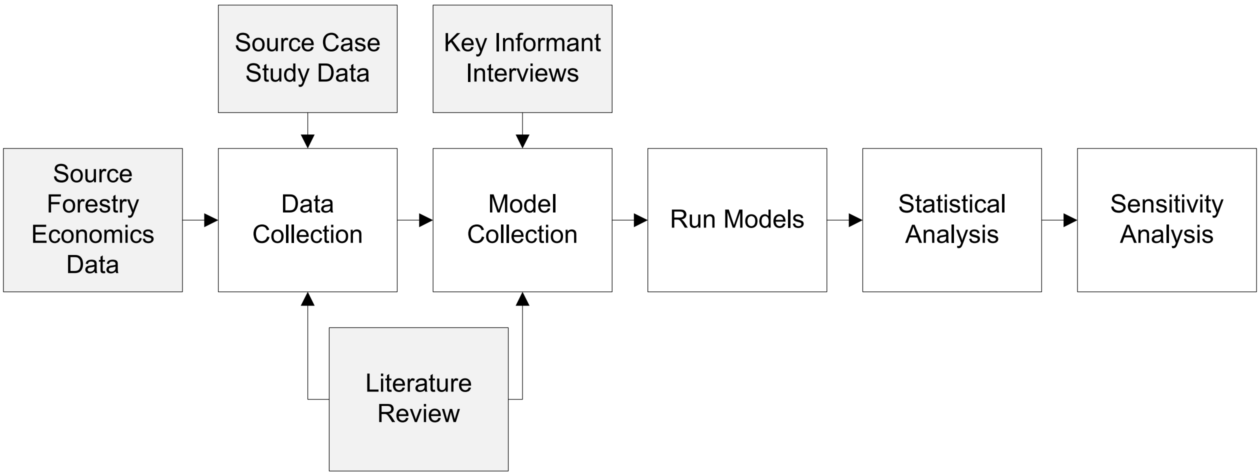


Figure 4.1: Research process flow.

Research results will also be described according to the sequence of research activities starting with the key informant interviews.

4.2 Observations from the key informant interviews

Most of the key informant interviewees felt that IAS 41 allows enough leeway for 'creative accounting' to take place, and all felt that due to the flexibility allowed within the standard, it would be very likely that variations would arise between valuation parties and between valuation results. It was also agreed by all interviewees that there are some practical difficulties that would need to be overcome in order for true standardisation to be achieved.

The interviewees provided a total of five unique valuation models that could be used for a variety of valuation purposes including financial reporting, insurance premiums, insurance claims, expropriation, willing buyer/seller valuations, land claims and biological asset valuation. The five identified models were complimented by one additional model (the Standing Value model) that was sourced from literature (Table 4.1).

Table 4.1: Models collected for the purposes of this study

Model Code	Description	Use within industry
SV	Standing Value	None of the interviewees use this methodology exclusively but it is used in conjunction with the CV model to form the MAX(CV,SV) model, and is described within the South African Forestry Handbook (Ham et al., 2012)
CV	Cost Value Method, commonly referred to as the "Faustmann" Method	Financial reporting, insurance premiums, insurance claims, expropriation, willing buyer/seller valuations, land claims, biological asset valuation
MAX(CV,SV)	Maximum of SV and CV	Financial reporting, insurance premiums, insurance claims, expropriation, willing buyer/seller valuations, land claims, biological asset valuation
DCF1	Discounted Cash Flow Model	Financial reporting, willing buyer/seller valuations, biological asset valuation
DCF2	Discounted Cash Flow Model	Financial reporting, expropriation, willing buyer/seller
NDSV	Net Discount Salvage Value	Financial reporting, expropriation, willing buyer/seller

4.2.1 Short overview of identified models

4.2.1.1 Standing value method

Although none of the interviewees makes exclusive use of the Standing value (SV) method, it is included as an input variable in some of the discounted cash flow models and forms part of the output of the MAX(CV,SV) model. SV refers to the value of standing marketable timber that is present in a stand at the time (age) when the value is required (Uys and Daugherty, 2000). At young ages, the standing value of a stand is zero. This is because after a stand is established and for a few years thereafter, a stand does not contain any merchantable timber and therefore has no SV (Ham et. al, 2012). For the purposes of this study, this utilisable age per yield class has been sourced from the case study data, and was initially derived from growth models which predict at which age each yield class produces merchantable timber (growth model tables available in Appendix 5).

SV for merchantable timber is determined by the volume of timber (that can be determined through an inventory) and the market price of the timber. SV is based on the availability of an active market for timber where the quoted price in the market should be used to determine a fair value for the tree crop (IASCF, 2009). When the timber market price used is the price paid for round wood delivered at roadside, the SV is calculated by subtracting the costs for felling, debranching, crosscutting and extraction from the gross value (Uys and Daugherty, 2000).

SV can be expressed as follows (Ham et al., 2012):

$$SV = SP \times CST$$

Equation 4.1: Standing Value (Ham et al., 2012)

Where:

SV = Standing Value
SP = Stumpage Price
CST = Current Merchantable Standing Tonnes

The components of this formula (Stumpage Price and Current Standing Tonnes) can be calculated in the following way:

Stumpage Price can be calculated by subtracting the harvesting and transport costs from the price paid at the point of delivery to market (MDP) (Straka, 2013).

$$SP = MDP - l$$

Equation 4.2: Stumpage Price (Straka, 2013)

Where:

SP = Stumpage Price
MDP = Mill Delivered Price
I = Harvesting and Transport Costs

$$CST = Age \times MAI(t) \times Area$$

Equation 4.3: Current Standing Tonnes (Immelman et al., 2007)

Where:

CST = Current Merchantable Standing Tonnes
MAI(t) = The Mean Annual Increment (in tonnes) of the compartment at the age of clearfelling.
Age = The age of the trees within the relevant compartment.
Area = The effective area (in hectares) of the compartment.

An example of how the SV method was implemented within this study can be found in Appendix 4.1.

4.2.1.2 Cost value method

Interviewees indicated that the Cost value (CV) method is also well recognised in forestry, and is preferred where legal implications exist, as it has been court approved (HILL v MERCROWE FORESTRY). The IRR used in the CV is also a function of the method and therefore cannot be disputed.

After a stand is established, and for the next few years, the stand does not contain any marketable timber and has no SV. The investment costs laid out for items such as establishment and tending result in these trees having an intangible market value or CV (Uys and Daugherty, 2000). In the CV calculation, only activities that took place up to the point in time where the calculation is done are taken into account. CV is calculated by compounding all past cost and revenue items from the ages at which it occurred to the age at which the CV is required. The difference between the compounded revenue and the compounded cost is the CV (Ham et al., 2012). In CV calculations the cost for the use of the land must be included. However when the land value forms a cost item at age zero and a revenue item at the age when the CV is required, the net result is zero, and therefore only the annual interest cost on the market value of the land needs to be included (Uys and Daugherty, 2000).

CV can be expressed as follows (Ham et al., 2012):

$$CV_p = \sum_{t=0}^{p}\left[-A_t(1+i)^{p-t}\right]$$

Equation 4.4: Cost Value (Ham et al., 2012)

Where

CV_p = Cost Value at age p;

A_t = Net cash flow in year t in terms of present day prices;

i = Internal Rate of Return (IRR) earned by the stand.

p = age.

The IRR which is earned by the specific plantation project is used as the compound or discount rate in the calculation of the plantations CV (Uys and Daugherty, 2000). The IRR is defined as the discount rate that is required to arrive at a NPV of zero (Bettinger et al., 2009). Thus when the present value of revenues minus the present value of costs equal zero, IRR can be calculated from the following formula (Ham et al., 2012):

$$\sum_{t=0}^{n}\frac{R_t}{(1+IRR)^t}-\sum_{t=0}^{n}\frac{C_t}{(1+IRR)^t}=0$$

Equation 4.5: Internal Rate of Return (Ham et al., 2012)

Where:

R_t = revenue in year t;

C_t = cost in year t;

n = duration of project (rotation).

An example of how the CV method was implemented within this study can be found in Appendix 4.2.

4.2.1.3 MAX(CV,SV) method

This method calculates the SV and CV at a required stand age and then selects the highest of the two values. When questioned about why this method is preferred, the interviewee stated: *"I use the MAX(CV,SV) model in all cases as I believe it offers the most realistic and practical estimate of the value of the plantations. It also provides a realistic replacement cost for any point within the growing cycle*".

An example of how the MAX(CV,SV) method was implemented within this study can be found in Appendix 4.3

4.2.1.4 Discounted cash flow method

The Discounted cash flow (DCF) method is a well established valuation method within the field of corporate finance (Shim and Siegel, 2008; Van Assen et al.,2009; Senanayake, 2010; O'Keefe et al., 2010). The purpose of the DCF analysis is to determine the money that will be received from an investment and to adjust for the time value of money (Shim and Siegel, 2008). The DCF method represents an approach founded on the theory of investment: the value of a company is determined (analogue to the determination of the value of an investment) based on the expected future cash flows which are discounted to the valuation date (Häcker and Ernst, 2011). DCF analysis uses future free cash flow projections and discounts them to arrive at a present value, which is used to evaluate the potential for investment (Van Assen et al., 2009).

$$DCF = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

Equation 4.6: Discounted Cash Flow (Shim and Siegel, 2008)

Where:

DCF	= present value of a security
Ct	= expected future cash flows in period t = 1...n
r	= the investor's required rate of return
n	= felling age

4.2.1.4.1 Discounted cash flow method 1

The starting point of this model is to determine whether the compartment has reached the relevant maturity age or not. This maturity age is in fact an average age determined by the interviewee, at which the average stand is said to have reached a point of financial feasibility (it has reached the point at which it can be used for pulpwood). From a growth and yield point of view, this age is similar to that which would be determined for the average biological rotation age of the plantations (Wahner, 2011). If the age of the compartment has exceeded this maturity age, then the SV is used. If not, then the future SV calculated at the relevant maturity age is discounted by the interest rate for the number of years the compartment requires to reach this maturity age, as shown by the following formula:

$$DCF1V = \frac{SV_M}{(1+i)^t}$$

Equation 4.7: Discounted Cash Flow 1 (Undisclosed Interviewee)

Where:

DCF1V	= DCF1 Value
SV_M	= Standing Value at maturity age
t	= number of years before the compartment reaches its maturity age.
i	= Interest Rate

For the purposes of testing this model against the input data, the maturity age values were calculated in line with the above logic, and set at 8 years for eucalypt, 9 years for wattle, and 14 years for Pine (2 years before felling age for each genus). An example of how the DCF1 method was implemented within this study can be found in Appendix 4.4.

The DCF1 model was the only model found to make provision for a risk premium. Literature indicates that for use within the DCF model, the discount rate can be determined based on the risk free rate plus a risk premium (Van Assen et al., 2009). This is based on the economic principle that money loses value over time, meaning that every investor would prefer to receive their money today rather than tomorrow. A small premium is therefore incorporated into the discount rate to give investors a small compensation for receiving their money in the future rather than now. For the purposes of this thesis, the standard real interest rate of 7.6% (as is derived in chapter 3) was used across all DCF models. Although this practice negates the effect of the risk premium on the output, it does make the DCF outputs comparable.

4.2.1.4.2 Discounted cash flow method 2

The interviewee using this method indicated that it is used when necessary to take into account market forces as well as own cost of capital. The interviewee concluded that due to these factors, "*I believe this model is the best fit for IFRS 13 valuation*".

The DCF2 value is calculated in the following way:

The DCF2 value at age n is calculated by subtracting the sum of future expenditures discounted to age n from the revenue at fell age discounted to age n.

$$DCF2V_n = DR_n - DE_{y-n}$$

Equation 4.8: Discounted Cash Flow 2 (Undisclosed Interviewee)

Where:

DCF2V = DCF2 value at age n

DR_n = Discounted revenue at age n.

y = Age at which expenditure occurs.

DE_{y-n} = Discounted expenditure (from age of expenditure to age n).

The discounted revenue is calculated in the following way:

$$DR_n = \frac{SV_f}{(1+DR)^{(f-n)}}$$

Equation 4.9: Discounted Revenue for DCF2 (Undisclosed Interviewee)

Where

SV_f = Standing value at fell age.

f = Fell age.

DR = Discount rate.

The discounted expenditure is calculated in the following way:

$$DE_y = \sum_{t=y}^{n} \frac{EC_t}{(1+DR)^{(t-y)}}$$

Equation 4.10: Discounted Expenditure for DCF2 (Undisclosed Interviewee)

Where

DE_y = Discount expenditure for year y.

y = Year for which discounted expenditure is being calculated.

n = Fell age.

EC_t = Expenditure costs for year t.

DR = Discount Rate

The DCF2 method allocates annual overhead costs from year 0. The CV method described previously only starts allocating annual overhead costs from year 1. The explanation given for this by the interviewee is that the model does this in order to cater for expenses performed in preparation of planting, even before a seedling is planted in the ground, overhead costs and other expenses must have been paid to secure the ground. The discount rate used for this method was calculated based on the WACC, but for the purposes of this thesis, the standard real interest rate of 7.6% was used across all DCF models (as is derived in chapter 3). An example of how the DCF2 method was implemented within this study can be found in Appendix 4.5

4.2.1.4.3 Net discount salvage value

The interviewee indicated that this method is preferred when buying a plantation where it is important to ensure timber supply in the future. "*The purchase price I would be willing to pay reflects the cost of the timber at current market prices less transport costs taking the time value of money into account. [If I have my own mill and plantation but only have 80 000 m^3 per year which is 80% capacity of the mill, and a plantation is for sale delivering 20 000 m^3 per year, I will buy the plantation so that my mill can run at 100% capacity]*".

The Net Discount Salvage Value (NDSV) model works in exactly the same manner as the 2nd Discounted Cash flow model (DFC2) described above. The only difference occurs in the calculation of discounted expenditure. Instead of discounting the total expenditure to the relevant age class in which a value is required, only annual overhead costs are used. The discount rate used for this method was calculated based on the WACC, but for the purposes of this thesis, the standard real interest rate of 7.6% was used across all DCF models (as is derived in chapter 3). An example of how the NDSV method was implemented within this study can be found in Appendix 4.6.

4.2.2 Short overview of identified parameter findings

As each model was collected from the interviewees, it was determined what inputs were required to enable each model to work correctly. The main input parameters include discount rate, yield, age, land value, selling prices and costs (Table 4.2).

Table 4.2: Required parameters per valuation model

	Models	**Standing Value**	**Cost Value**	**Maximum of SV and CV**	**Discounted Cash Flow Model 1**	**Discounted Cash Flow Model 2**	**Net Discount Salvage Value**
No.	**Model Codes**	**SV**	**CV**	**MAX(CV,SV)**	**DCF1**	**DCF2**	**NDSV**
1	Discount Rate				X	X	X
2	Yield (MAI)	X	X	X	X	X	X
3	Age	X	X	X	X	X	X
4	Land Value		X	X			
5	Establishment and Maintenance Costs	X	X	X	X	X	X
6	Harvesting and Logistics Costs	X	X	X	X	X	X
7	Market Prices	X	X	X	X	X	X

Age class and yield were identified as two significant parameters that could have a substantial effect on valuation outputs.

4.2.2.1 Age class

All interviewees were found to be using some form of age class grouping. In total, three different methodologies of age class grouping were encountered within the collected models, these were:

- Rounding to the nearest whole number.
- Rounding up.
- Rounding to the nearest 0.5.

All of these methods are acceptable by IAS 41 standards. Age class findings are further discussed in chapter 4.5.1.

4.2.2.2 Yield (MAI)

The majority of interviewees confirmed that a straight line MAI was used, while some of the interviewees were found to use a growth model in the calculation of relative volumes at different ages to be used as inputs into their valuation models. The use of straight line MAI versus volume derived from growth models is further discussed in chapter 4.5.2.

4.3 Case study plantation valuation

The six valuation models were used to value the case study plantation based on the plantation data which can be found in Appendix 1. Each model provided a different total plantation value (Table 4.3) with the DCF1 model providing the highest value (R 36,819,848) and the DCF2 model providing the lowest value (R 28,213,537), resulting in a R 8,606,311 or 30.5% variation in range between maximum and minimum values between these six models.

Table 4.3: Valuation of case study plantation data by collected valuation models

Model	Valuation Total
SV	R 29,508,770
CV	R 32,639,545
MAX(CV,SV)	R 32,746,416
DCF1	R 36,819,848
DCF2	R 28,213,537
NDSV	R 28,596,105

To understand the reason for the variation between total plantation values for the six models the valuation outputs from these models were compared over the different genera making up the case study plantation data.

4.4 Analysis

4.4.1 Genus / model comparison

Comparing output model values by genus indicates that outputs between models are significantly different per genus ((p-value < 0.05 for all three genera). In order to determine whether or not genus is a contributing factor to the significant difference between models, the three genera (Eucalypt, Pine and Wattle) are analysed separately.

When the per genus valuation results for the case study plantation were analysed it was found that there are significant differences between model output values for the pine, eucalypt and wattle data ($p < 0.05$ for all three genera) (Table 4.4).

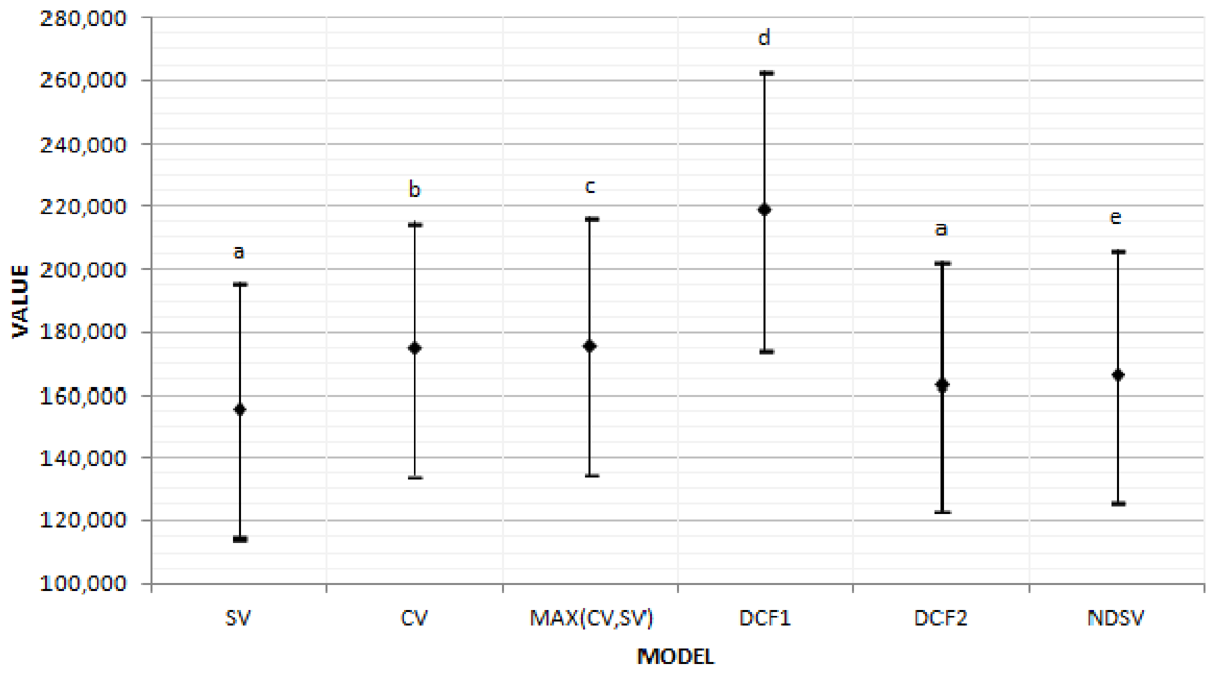
Table 4.4: Calculated case study value per model per genus (G – Eucalypt, P – Pine, W – Wattle)

GENUS	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV	% Range Variance
G	R 16,470,535	R 18,513,206	R 18,594,053	R 23,170,118	R 17,258,231	R 17,615,797	40.7%
P	R 5,445,059	R 6,460,658	R 6,460,658	R 5,985,825	R 3,584,098	R 3,609,099	80.3%
W	R 7,593,176	R 7,665,681	R 7,691,706	R 7,663,905	R 7,371,208	R 7,371,208	4.6%
Total	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105	30.5%

An analysis of these variations identified the following:

4.4.1.1 Eucalypt

Comparisons between model value outputs per eucalypt compartments (using repeated measures ANOVA with bootstrapping) indicates that only the SV x DCF2 model pair is not significantly different from each other (p=0.05) (Figure 4.2). All other models are deemed to be significantly different from each other (p<0.05). The significance of differences between model valuation means per genus is further discussed in chapter 5.3.1.1.

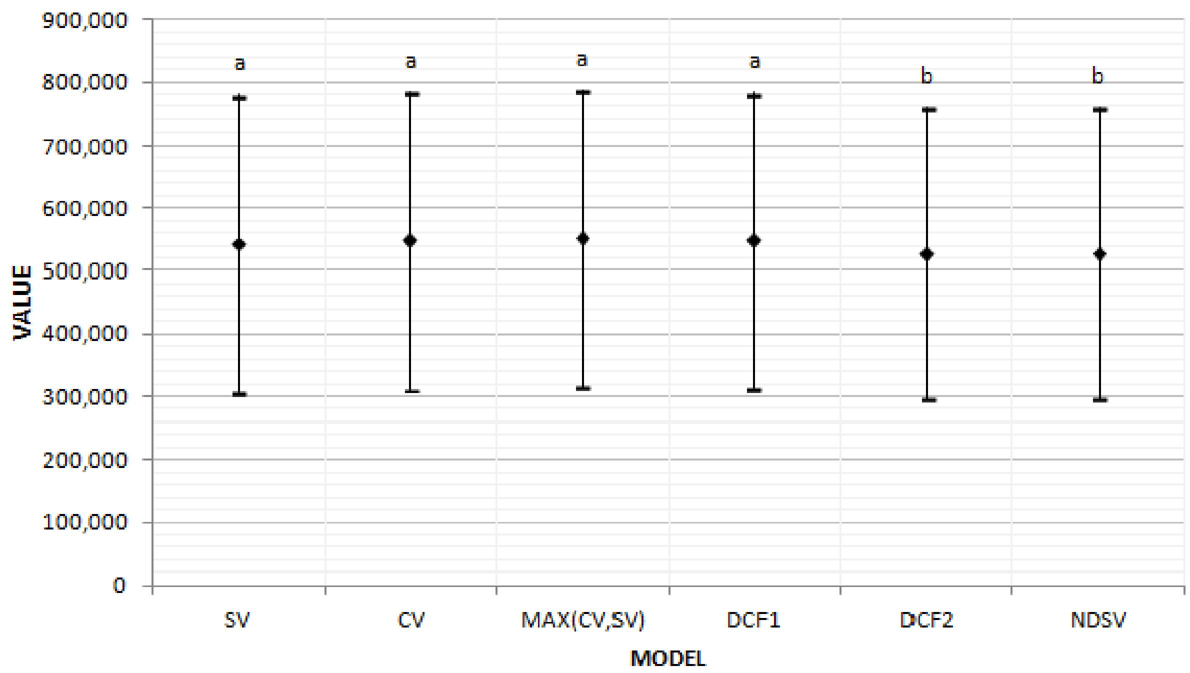


Vertical bars denote 0.95 bootstrap confidence intervals.

Figure 4.2: Bootstrap means and confidence intervals per model for eucalypt data.

4.4.1.2 Wattle

Due to the inadequate sample size (only 14 wattle compartments in the case study data), the bootstrap multiple comparisons test could not be used. Instead, the non-parametric multiple comparison Wilcoxon test with Bonferroni corrected p-values confirmed that the DCF2 and NDSV model means are not significantly different from each other (p=1.00), but are significantly different from those of all the other models. The SV, CV, MAX(CV,SV) and DCF1 model valuation means per compartment were found to be not significantly different from each other: SV x CV (p=1.00), SV x MAX(CV,SV) (p=0.137), SV x DCF1 (p=1.00), CV x MAX(CV,SV) (p=0.886), CV x DCF1 (p=1.00), MAX(CV,SV) x DCF1 (p=1.00). The least square means and LSD (least significant difference) confidence intervals illustrate this (Figure 4.3). One of the possible explanations for the low degree of significant differences (or high p-value) found between models could be that the relatively small sample of wattle compartments (14) are all relatively close to maturity age (between 7 and 11 years old, Table 3.1).

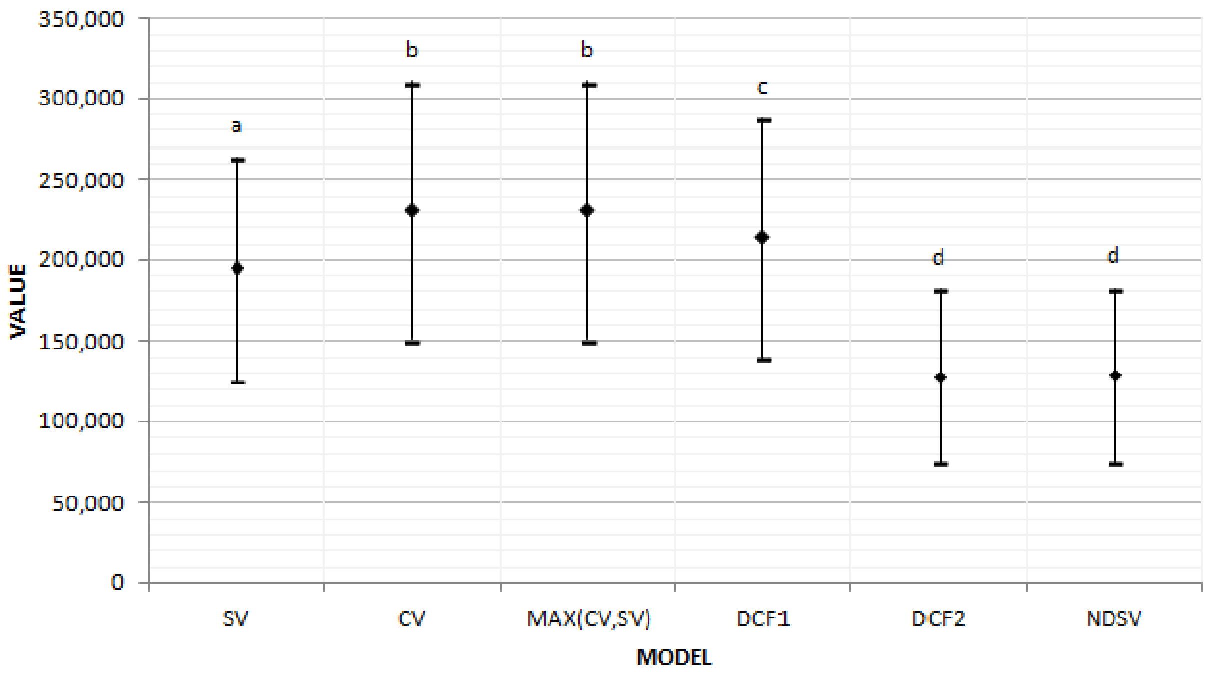


Vertical bars denote 0.95 bootstrap confidence intervals.

Figure 4.3: Least square means and LSD confidence intervals per model for wattle data.

4.4.1.3 Pine

Using repeated measures ANOVA with bootstrapping, no significant differences were found for pine compartment valuations for the following model pairs: CV x MAX(CV,SV) (p=1.00) and DCF2 x NDSV (p=1.00). All other pairs of models were found to be significantly different to each other (p<0.05) (Figure 4.4). The effect of the longer rotation period can be seen, as the models making use of discounting are seen to have lower means than the other models relative to where they were for the shorter rotation eucalypt and wattle data.



Vertical bars denote 0.95 bootstrap confidence intervals.

Figure 4.4: Bootstrap means and confidence intervals per model for pine data.

4.4.2 Further analysis

The previous section indicates that there are variations in valuation models between the different genera. To further investigate variation in total plantation values between the six models (and for the same genus) the valuation outputs from these models were compared over the different yield and age classes of the case study plantation data.

4.4.2.1 Analysing the output differences between age classes

When the outputs of models are compared per genus and age class it would seem (from the percentage range differences) that the difference between model output values become smaller and disappear towards end of rotation. Variation between model output values becoming non-significant ($p>0.05$) as age class increases, reaching 1 (not significant) at fell age (Table 4.5 and Figures 4.5, 4.6 and 4.7).

Table 4.5: Case study dataset percentage range differences by genus and age class (G – Eucalypt, P – Pine, W – Wattle)

GENUS	Age Class	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV	% Range Diff
G	1	R 0	R 206,905	R 206,905	R 460,559	R 176,280	R 225,817	
	2	R 562,347	R 808,801	R 808,801	R 1,449,408	R 818,490	R 866,748	158%
	3	R 3,992,508	R 4,898,511	R 4,898,511	R 7,381,646	R 4,760,336	R 4,850,534	85%
	4	R 2,856,825	R 3,440,770	R 3,440,770	R 4,262,502	R 2,740,989	R 2,804,093	56%
	5	R 479,966	R 565,197	R 565,197	R 616,444	R 412,833	R 423,437	49%
	6	R 1,762,758	R 1,819,166	R 1,819,166	R 2,030,051	R 1,703,146	R 1,729,451	19%
	7	R 2,468,457	R 2,413,771	R 2,480,617	R 2,621,834	R 2,425,822	R 2,455,402	9%
	8	R 3,156,857	R 3,170,618	R 3,181,864	R 3,156,857	R 3,042,708	R 3,082,689	5%
	9	R 929,447	R 928,099	R 930,853	R 929,447	R 916,258	R 916,258	2%
	10	R 261,370	R 261,370	R 261,370	R 261,370	R 261,370	R 261,370	0%
G Total		R 16,470,535	R 18,513,206	R 18,594,053	R 23,170,118	R 17,258,231	R 17,615,797	41%
P	3	R 52,202	R 102,288	R 102,288	R 108,832	-R 3,995	R 3,843	2824%
	5	R 356,471	R 541,783	R 541,783	R 516,263	R 110,105	R 127,268	392%
	8	R 1,800,237	R 2,276,762	R 2,276,762	R 2,029,991	R 961,855	R 961,855	137%
	9	R 1,193,355	R 1,415,973	R 1,415,973	R 1,287,045	R 741,369	R 741,369	91%
	13	R 1,048,096	R 1,101,128	R 1,101,128	R 1,048,995	R 882,039	R 882,039	25%
	14	R 936,877	R 962,663	R 962,663	R 936,877	R 840,205	R 840,205	15%
	15	R 57,821	R 60,061	R 60,061	R 57,821	R 52,521	R 52,521	14%
P Total		R 5,445,059	R 6,460,658	R 6,460,658	R 5,985,825	R 3,584,098	R 3,609,099	80%
W	7	R 640,061	R 647,944	R 647,944	R 710,790	R 626,120	R 626,120	14%
	9	R 2,386,358	R 2,473,666	R 2,473,666	R 2,386,358	R 2,251,578	R 2,251,578	10%
	10	R 4,566,758	R 4,544,072	R 4,570,096	R 4,566,758	R 4,493,510	R 4,493,510	2%
W Total		R 7,593,176	R 7,665,681	R 7,691,706	R 7,663,905	R 7,371,208	R 7,371,208	4%
Grand Total		R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105	31%

As the age approaches fell age (for all genera) the model output values converge to the same point, so that at fell age all models calculate the exact same output value (Figures 4.5, 4.6 and 4.7). This is because at fell age, all the market variables are known and values can be accurately determined through the standing value calculation, as is discussed in chapter 5.3.1.2.

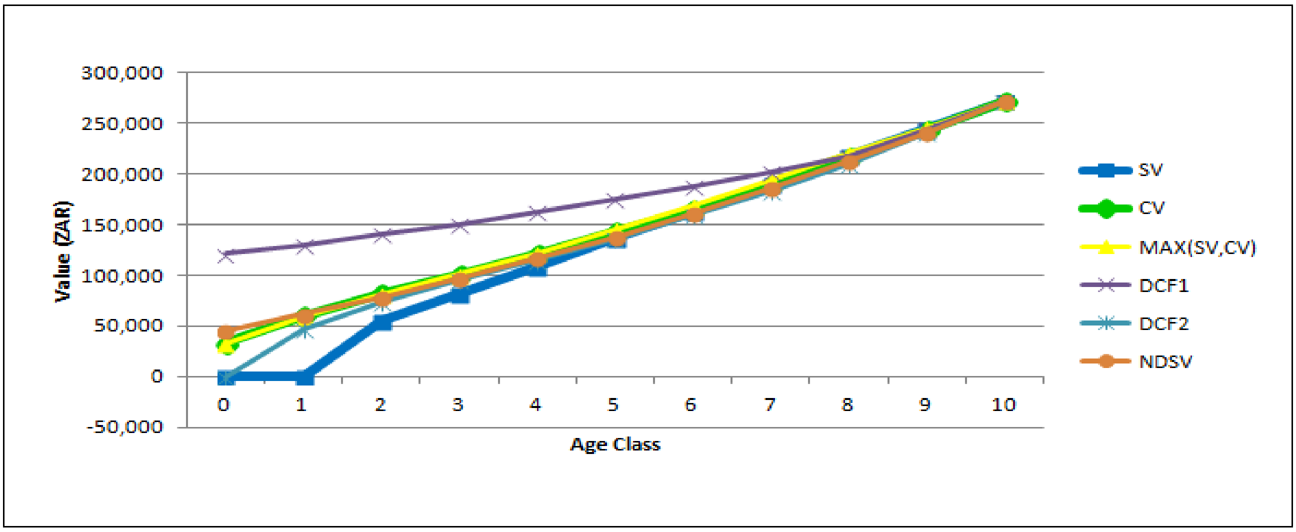


Figure 4.5: Output value per model per age class for eucalypt.

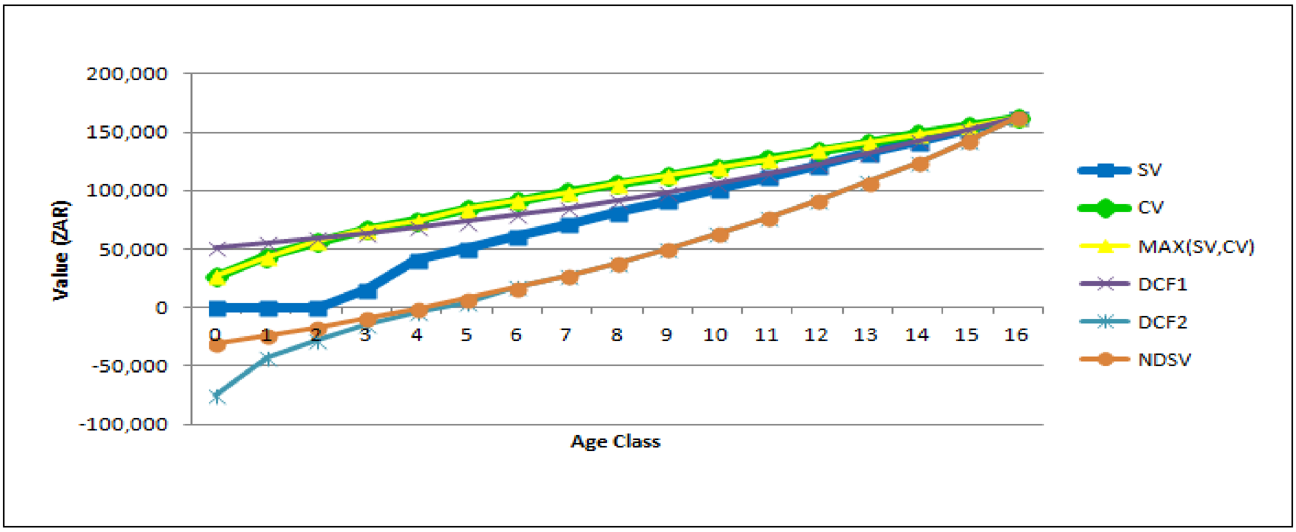


Figure 4.6: Output value per model per age class for pine.

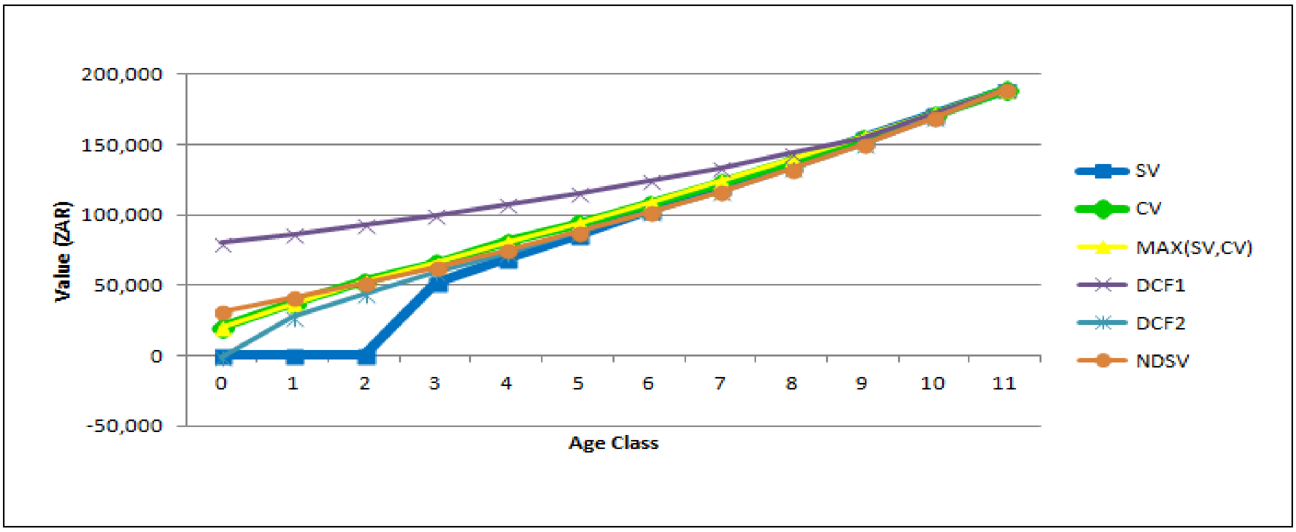


Figure 4.7: Output value per model per age class for wattle.

Although the generation of negative values (for the NDSV and DCF2 models) is counter-intuitive (seen in Figure 4.6), literature has confirmed that the outcome of a DCF-based valuation can be negative under certain conditions (Wagnière, 2011). This is further discussed in chapter 5.2.1.4.

4.4.2.2 Analysing the output differences between yield classes

Graphs depicting value per model per yield class show that lower yield classes are more likely to have greater significant differences than higher yielding classes. This trend is most visible for pine, but can also be observed as fell age is approached for eucalypt and wattle. When model outputs are compared across yield class and genus there are significant differences between models for all genera ($p < 0.05$) and for every yield class ($p < 0.05$) and differences increase at lower yield classes as illustrated by Figures 4.8 - 4.13. The model value outputs per yield class for the case study data is presented in Table 4.6.

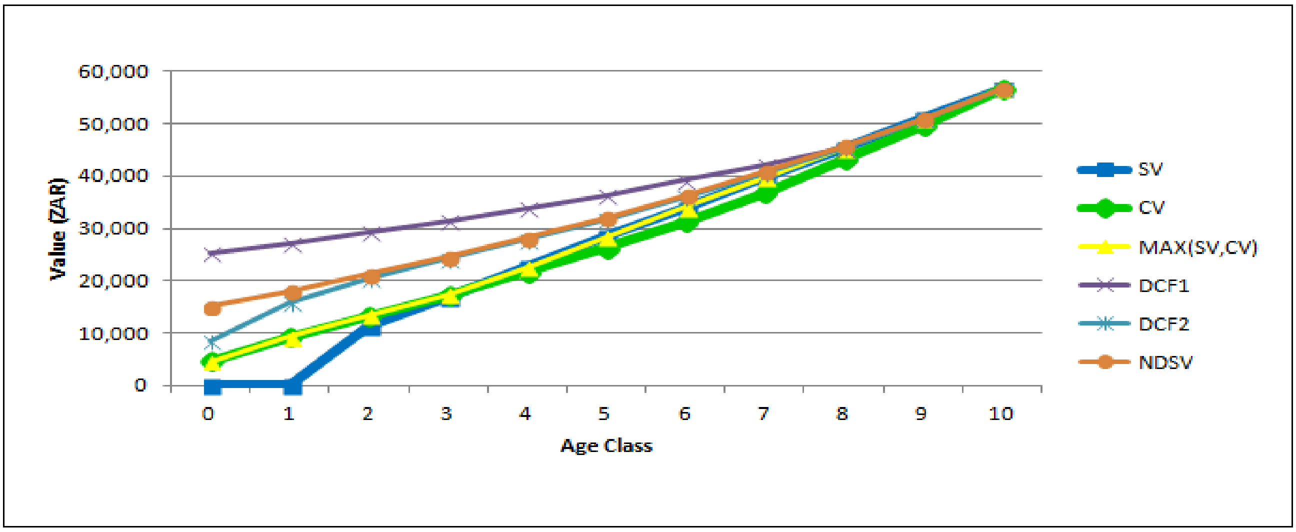


Figure 4.8: Value per hectare per Age Class and Yield Class for highest (G.1) eucalypt yield class.

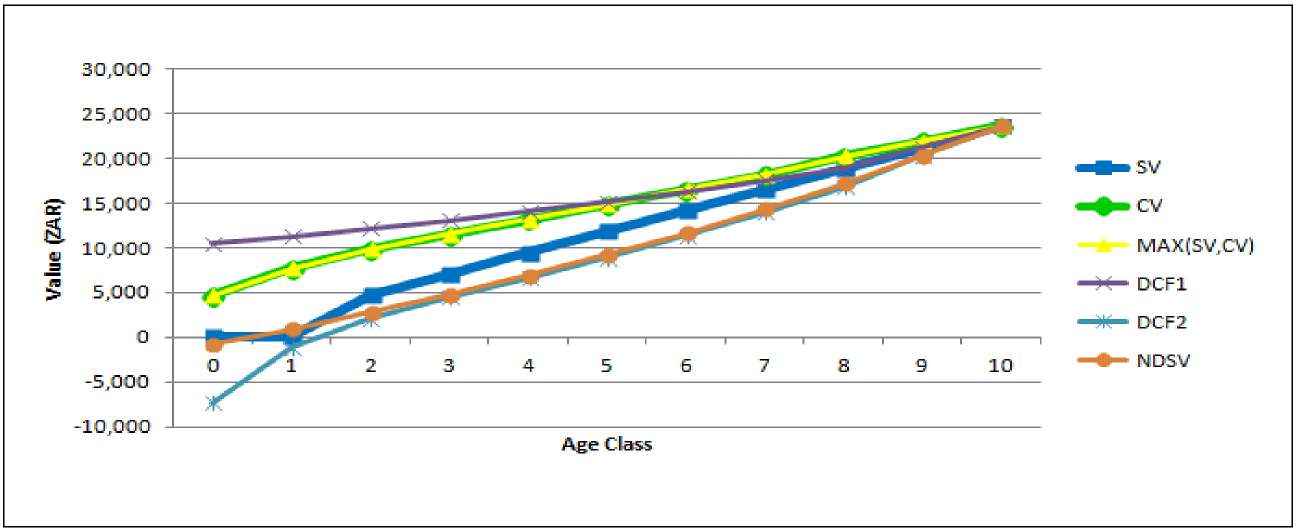


Figure 4.9: Value per hectare per Age Class and Yield Class for lowest (G.7) eucalypt yield class.

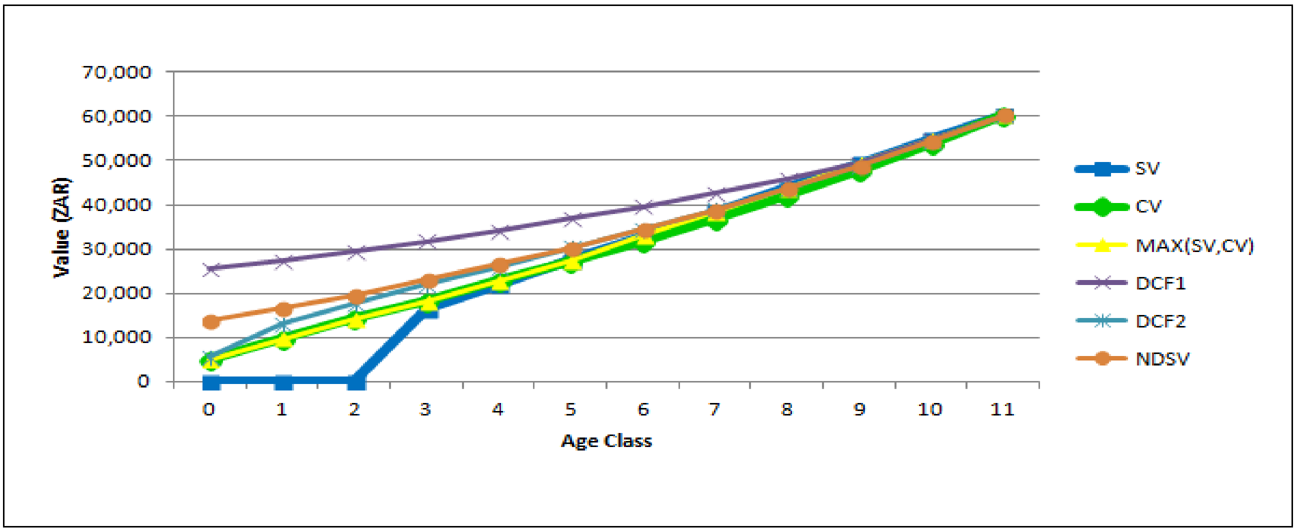


Figure 4.10: Value per hectare per Age Class and Yield Class for highest (W.1) wattle yield class.

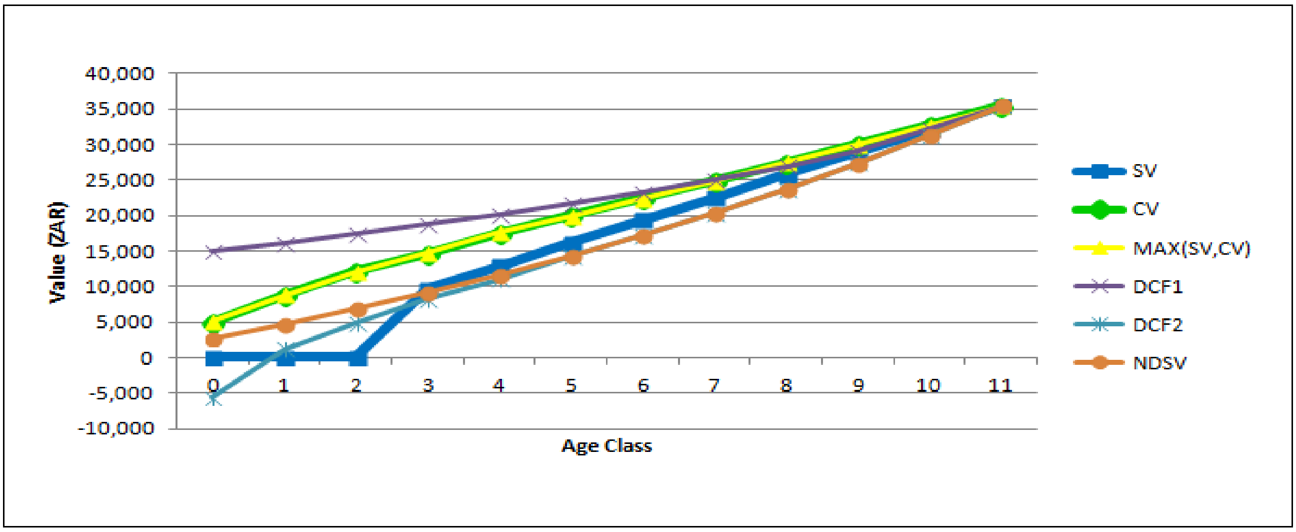


Figure 4.11: Value per hectare per Age Class and Yield Class for lowest (W.4) wattle yield class.

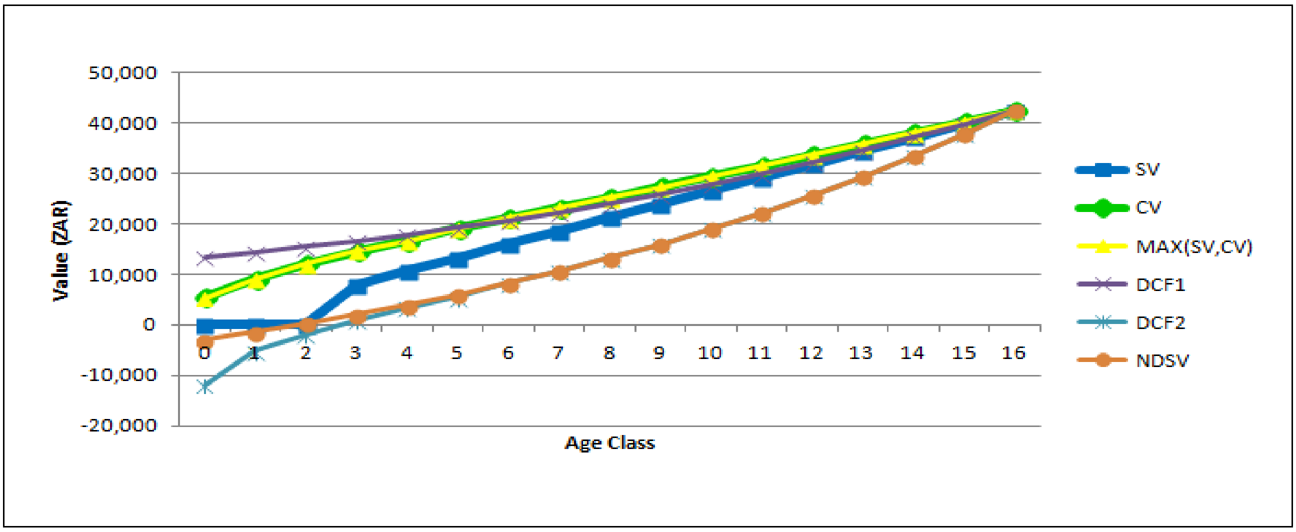


Figure 4.12: Value per hectare per Age Class and Yield Class for highest (P.1) pine yield class.

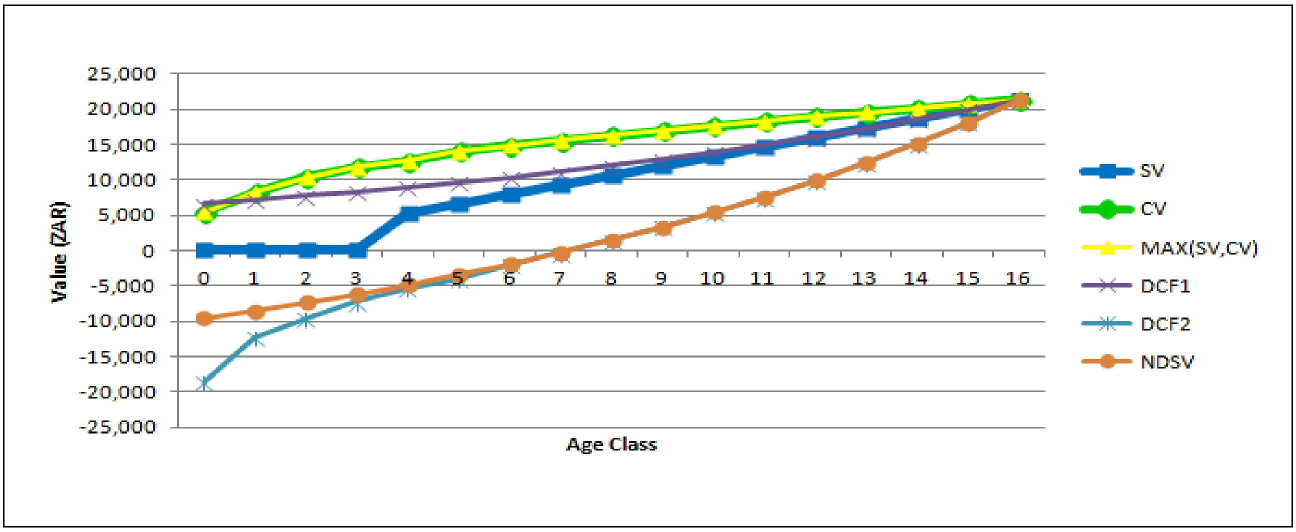


Figure 4.13: Value per hectare per Age Class and Yield Class for lowest (P.5) pine yield class.

Table 4.6: Case study dataset valuation by genus and yield class (G – Eucalypt, P – Pine, W – Wattle)

GENUS	Yield Class	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
G	G.1	R 750,363	R 696,615	R 750,363	R 796,987	R 766,238	R 773,123
	G.2	R 361,782	R 396,508	R 396,508	R 668,890	R 487,203	R 493,806
	G.3	R 5,383,984	R 6,111,209	R 6,138,307	R 8,351,705	R 6,202,622	R 6,353,112
	G.4	R 6,390,093	R 6,973,356	R 6,973,356	R 8,356,308	R 6,487,432	R 6,594,679
	G.5	R 2,609,067	R 3,051,159	R 3,051,159	R 3,581,859	R 2,549,496	R 2,609,005
	G.6	R 483,227	R 624,380	R 624,380	R 720,995	R 411,047	R 423,504
	G.7	R 492,018	R 659,980	R 659,980	R 693,374	R 354,193	R 368,569
G Total		R 16,470,535	R 18,513,206	R 18,594,053	R 23,170,118	R 17,258,231	R 17,615,797
P	P.1	R 926,461	R 1,000,002	R 1,000,002	R 960,132	R 734,156	R 734,156
	P.2	R 2,997,012	R 3,538,955	R 3,538,955	R 3,341,411	R 2,031,726	R 2,056,727
	P.3	R 1,463,765	R 1,861,640	R 1,861,640	R 1,626,461	R 765,696	R 765,696
	P.5	R 57,821	R 60,061	R 60,061	R 57,821	R 52,521	R 52,521
P Total		R 5,445,059	R 6,460,658	R 6,460,658	R 5,985,825	R 3,584,098	R 3,609,099
W	W.1	R 1,129,368	R 1,107,904	R 1,129,368	R 1,129,368	R 1,119,840	R 1,119,840
	W.2	R 1,491,988	R 1,495,311	R 1,499,871	R 1,562,717	R 1,464,859	R 1,464,859
	W.3	R 2,585,462	R 2,588,801	R 2,588,801	R 2,585,462	R 2,534,931	R 2,534,931
	W.4	R 2,386,358	R 2,473,666	R 2,473,666	R 2,386,358	R 2,251,578	R 2,251,578
W Total		R 7,593,176	R 7,665,681	R 7,691,706	R 7,663,905	R 7,371,208	R 7,371,208
Grand Total		R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105

4.5 Parameter constraints identified during key informant survey

During the key informant survey, MAI and Age were highlighted as two potential input parameters that could have a large effect on valuations variances, as different interviewees were found to apply these two parameters in different ways.

4.5.1 Yield (MAI)

The difference in annual yield (volume) between growth model and straight line MAI estimates is illustrated by Figure 4.14. The volume calculated using the growth model (e.g. for yield class G.1 eucalypt) will usually be less than that calculated with the straight line MAI until fell age, where the two yield calculations will produce the same result. This difference in volume estimate will have an effect on the different valuation models as it is evident that straight line MAI will calculate higher yields at lower ages, resulting in a larger average yield. To illustrate the possible magnitude of this difference in application, the case study plantation value is calculated by means of the straight line MAI method as well as with a growth and yield simulator. Table 4.7 illustrates the differences in value for the case study plantation as a result of the two different methods of calculating yield.

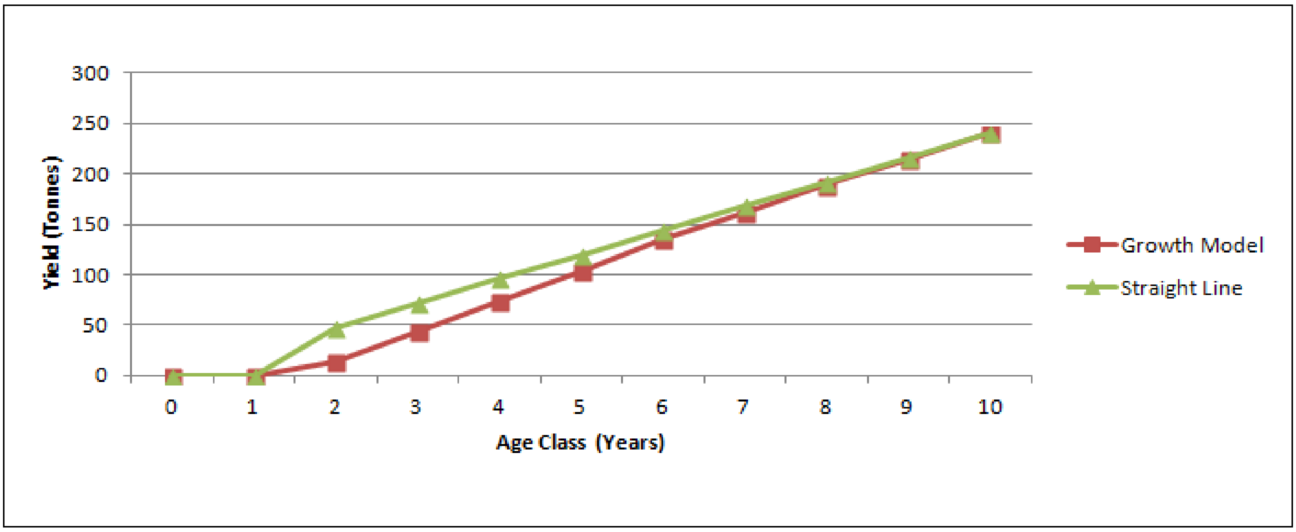


Figure 4.14: Yield per age class for G.1 yield class of eucalypts.

Table 4.7: Valuation per model using straight line MAI(t) versus growth model MAI(t)

	SV	**CV**	**MAX(CV,SV)**	**DCF1**	**DCF2**	**NDSV**
Straight Line MAI(t)	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105
Growth Model MAI(t)	R 24,403,797	R 32,639,545	R 32,808,888	R 36,194,524	R 28,213,537	R 28,596,105
Difference	R -5,104,973	R 0	R 62,471	R -625,324	R 0	R 0

The total standing value for the case study plantation is decreased when using the MAI(t) generated from the relevant growth models per age and yield class, instead of the straight line MAI(t). This is because at younger ages lower volumes are calculated due to the lower MAI(t), as illustrated by the MAI per yield and age class for eucalypt in Figure 4.15.

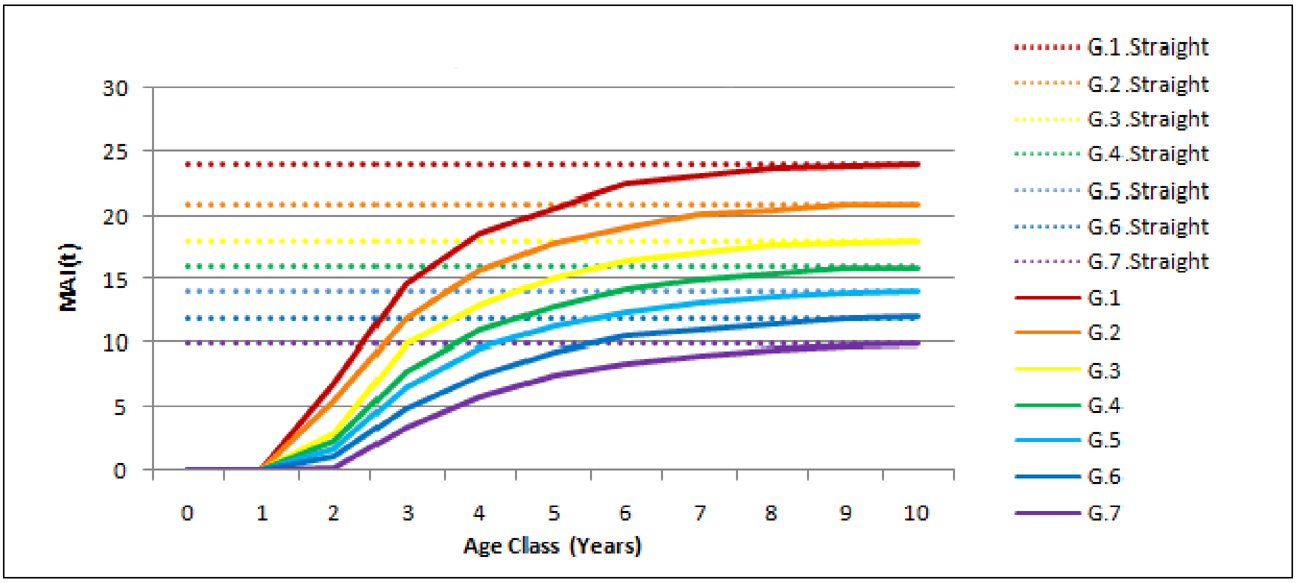


Figure 4.15: Growth Model vs Straight Line MAI(t) per yield and age class for eucalypt.

The graphs generated by the growth model all illustrate the point that growth model MAI(t) starts at zero, and gradually increase as the tree approaches maturity. It must be noted here that it is possible for growth models to produce higher projected yields than straight line MAI's for ages less than fell age, as is seen in Figure 4.16.

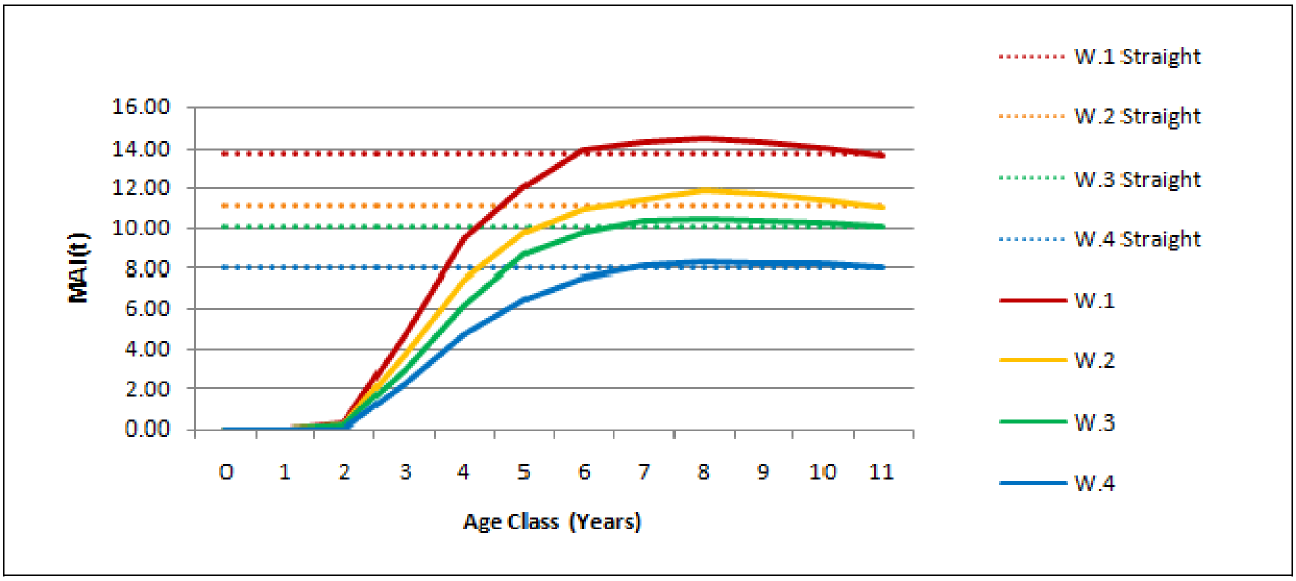


Figure 4.16: Growth Model vs Straight Line MAI(t) per yield and age class for wattle

In this case the calculation of wattle growth model MAI's results in MAI's larger than the straight line MAI value, for compartments between 6 years and fell age (11 years). This explains why the MAX(CV,SV) model calculates a slightly higher plantation value using growth model MAI's (Table 4.8), as the Standing Values calculated for these wattle compartments between 6 and 11 years old using growth model MAI's will be higher than those calculated using the straight line MAI.

The Cost Value, DCF2 and NDSV models use the final value at fell age (SV) as the base from which valuations per compartment are calculated. They are therefore unaffected by the change in MAI or the effect that these changes may have before a final MAI at fell age is reached. The SV model is the most affected by the use of growth model versus straight line MAI, with straight line MAI resulting in R5 million more in value than that obtained with growth models. This is because of an overestimation of volume in the younger age classes. The DCF1 model discounts the standing value at maturity age (Equation 4.7), and not at fell age like the other DCF models. Growth model MAI is less than straight line MAI at maturity age, and therefore DCF1 valuation using growth model MAI results in R 625,324 less than that calculated with straight line MAI.

4.5.2 Age class

As has been discussed earlier within this study, all interviewees were found to be using some form of age class grouping. All methods for calculating age class grouping are accepted, as IAS 41 does not stipulate a method for doing so. The following three methodologies of age class grouping were found to be used by the interviewees:

4.5.2.1 Rounding to the nearest whole number

This age class grouping method is based on rounding the actual age to the nearest whole number. In this method any real age between 0.5 and 1.4 is grouped within age class 1, any age between 1.5 and 2.4 is grouped within age class 2, and so forth.

4.5.2.2 Rounding up

This age class grouping method rounds ages up to a whole number. In this method, an age class of 0 will only be assigned to an unplanted compartment. In this methodology, a 0.2 year old compartment will be included within the 1 year old age class. This methodology is the most commonly used by interviewees within this study.

4.5.2.3 Rounding to 0.5

This age class grouping method rounds the actual age to the nearest 0.5 age class. So all unplanted compartments are contained within the 0 age class, any compartment less than 1 year old will be grouped within the 0.5 year old age class, any compartment between 1 and 2 years old will fall within the 1.5 year old age class, and so forth.

To illustrate the possible magnitude of this difference in application the case study plantation value is recalculated using the following age class calculation methods, all of which are acceptable by IAS 41 requirements:

- Rounding up, used by the majority of interviewees.
- Rounding to the nearest whole number, the default baseline methodology used within this study.
- Rounding to 0.5
- Rounding down, not used by any interviewees, but gives an idea of the possible range of variance accepted within IAS 41 compliance.

The following weighted ages (weighted by hectares), for the case study plantation, were calculated for the different age rounding methods (Table 4.8):

Table 4.8: Effect on weighted age by rounding default age class up and down

Age Class	Weighted Age (Years)	%Change
Round Up	6.47	7.60%
Actual Age	6.04	0.38%
Round to Nearest Whole Number (Default baseline)	6.01	0.00%
Round to 0.5	5.97	-0.71%
Round Down	5.47	-9.03%

The calculated weighted age of the actual ages (weighted by hectares), is shown to be 6.04 years. Rounding to the nearest whole number results in a weighted age of 6.01 years, which is the age class grouping methodology which results in a weighted age closest to the value of the actual age. Rounding to 0.5 gives an average weighted age of 5.97, which is (as to be expected) also relatively close to the actual weighted age of 6.04. As can be seen from Table 4.8, the round down methodology for calculating age class lowered the weighted age class age from 6.01 years (default age class rounding methodology) to 5.47, a decrease of 9.03% in weighted age. The rounding up methodology increased the weighted age class from 6.01 years to 6.47 years, an increase of 7.60% from 6.01.

All of the model valuations are affected significantly by the effect of age class rounding (Table 4.9). The effective variance in range generated by rounding (between the rounding up and rounding down methodology) results in an average difference of R 4,351,937 for the six different valuation models.

Table 4.9: Effect on plantation valuation per model by a change in age class rounding logic

Age Class Methodology	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
Round Up	R 31,741,197	R 34,539,834	R 34,626,297	R 38,286,522	R 30,404,238	R 30,784,068
Round to Nearest Whole Number (Default baseline)	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105
Round to 0.5	R 28,784,894	R 31,574,467	R 32,398,343	R 36,132,890	R 27,710,501	R 28,076,671
Round Down	R 26,428,771	R 30,264,172	R 30,373,016	R 35,401,337	R 25,566,530	R 26,236,711
Difference	R 5,312,426	R 4,275,662	R 4,253,281	R 2,885,185	R 4,837,708	R 4,547,358

These results will be used later in the sensitivity analysis to determine the effect that age has on the model output values (chapter 4.6.3).

4.6 Sensitivity analysis

The different valuation models rely on a number of input parameters such as timber volume, costs and market prices. These parameters were previously identified for the collected models within the model collection process (Table 4.2). Changes in these parameters could affect the valuation models to different degrees. Through a sensitivity analysis where selected parameters are varied one at a time (OFAT) while all others are held constant, the effect of change on a model can be assessed.

These model input parameters were used within the sensitivity analysis to determine the effect of each of these parameters on the output value calculated by each model. The following parameters were tested:

- Discount rate
- Volume as a function of yield (MAI)
- Age
- Land value

- Input (establishment and maintenance) costs
- Harvesting and Logistics (mill delivery) costs
- Market price.

4.6.1 Discount Rate

The impact of the discount rate on the model output values was tested by determining what change in discount rate is needed to change the model output valuation value by 10%, 15% and 20% respectively (Table 4.10).

A change in discount rate has no effect on the SV, CV and MAX(CV,SV) models. The CV model makes use of a calculated IRR per project (in this case, per yield class) and is therefore not affected by discount rate in any way.

Table 4.10: Required discount rate to achieve +/-10%, +/-15% and +/-20% change in model output valuation for the DCF1, DCF2 and NDSV models

% Change in Model Output Valuation	DCF1	Discount Rate (%)	DCF2	Discount Rate (%)	NDSV	Discount Rate (%)
20%	R 44,183,818	1.15	R 33,856,244	4.10	R 34,315,325	4.08
15%	R 42,342,825	2.54	R 32,445,568	4.90	R 32,885,520	4.88
10%	R 40,501,833	4.07	R 31,034,891	5.74	R 31,455,715	5.73
0	R 36,819,848	7.60	R 28,213,537	7.60	R 28,596,105	7.60
-10%	R 33,137,863	12.00	R 25,392,183	9.74	R 25,736,494	9.75
-15%	R 31,296,871	14.66	R 23,981,506	10.93	R 24,306,689	10.96
-20%	R 29,455,878	17.73	R 22,570,830	12.23	R 22,876,884	12.27

For the DCF1 model, a 10% increase in model generated plantation valuation is achieved by decreasing the interest rate from 7.6% to 4.07% (a reduction of 3.53 percentage points). A 10%

increase in model generated plantation value for the DCF2 model is achieved by decreasing the interest rate from 7.6% to 5.74%, (a reduction of 1.86 percentage points). For the NDSV model, a 10% increase in model generated plantation value is achieved by decreasing the interest rate from 7.6% to 5.73% (a decrease of 1.87 percentage points),

As the DCF2 method requires the least amount of change in percentage points to bring about a 10% change in valuation value (1.86 percentage points for DCF2) it seems that the DCF2 is most affected by a change in interest rate (confirmed by fractional ranking) followed closely by NDSV. DCF1 is far less affected by interest rate. Considering that in the DCF1 model discount rate plays no role once timber is recognised as being mature (2 years before fell age) (Equation 4.7) this is to be expected. The SV, CV and MAX(CV,SV) models are not affected at all by interest rate.

4.6.2 Input yield difference (MAI)

4.6.2.1 Effect of change in default straight line MAI(t)

To estimate the effect of changes in straight line MAI(t) (MAI's shown in Table 3.2) on model outputs MAI was increased by 5%, 10%, 20%, 50% and 100% respectively.

The change in MAI(t) input is directly proportional to the model valuation output value for the SV, DCF1, DCF2 and NDSV models. For every 10% increase in MAI(t), the SV, DCF1, DCF2 and NDSV models experience an increase in output valuation value of 10%, 10%, 13.75% and 13.57% respectively (from Table 4.11). At low MAI(t) the DCF2 and NDSV model valuation values become negative.

Table 4.11: Model valuation per model and percentage change in MAI(t)

%Change	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
100%	R 59,017,539	R 53,857,976	R 59,322,393	R 73,639,696	R 67,011,872	R 67,394,440
50%	R 44,263,155	R 43,736,929	R 45,320,682	R 55,229,772	R 47,612,705	R 47,995,272
20%	R 35,410,524	R 37,225,263	R 37,656,050	R 44,183,818	R 35,973,204	R 36,355,772
10%	R 32,459,647	R 34,960,292	R 35,188,439	R 40,501,833	R 32,093,370	R 32,475,938
5%	R 30,984,208	R 33,807,279	R 33,961,523	R 38,660,840	R 30,153,454	R 30,536,021
0	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105
-5%	R 28,033,331	R 31,456,217	R 31,525,059	R 34,978,856	R 26,273,620	R 26,656,188
-10%	R 26,557,893	R 30,256,331	R 30,302,896	R 33,137,863	R 24,333,703	R 24,716,271
-20%	R 23,607,016	R 27,802,482	R 27,822,946	R 29,455,878	R 20,453,870	R 20,836,438
-50%	R 14,754,385	R 19,900,969	R 19,900,969	R 18,409,924	R 8,814,369	R 9,196,937
-100%	R 0	R 3,287,876	R 3,287,876	R 0	-R 10,584,798	-R 10,202,231

The results in Table 4.11 were used to calculate the sensitivity index (as described in chapter 3.4.2.1), and are shown in Table 4.12.

Table 4.12: Sensitivity index calculated per model for the effect on model valuation by MAI(t)

SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
1.000	0.939	0.945	1.000	1.158	1.151

When the effects that a change in MAI(t) has on the model value output are ranked, it seems that the DCF2 model is the most sensitive to change in MAI(t) followed by the NDSV model (Table 4.13).

Table 4.13: Fractional ranking of valuation models where [1] denotes the valuation model most affected by the change in MAI(t)

	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
Fractional Ranking	3.5	6	5	3.5	1	2

4.6.3 Age class

In chapter 4.5.2 it was shown that a 7.60% increase in the weighted age is achieved by rounding up the age of the case study compartments, compared to the use of the "round to the nearest whole number" methodology used as the default baseline within this study. Similarly, a 9.03% decrease in the weighted age is achieved through the rounding down methodology. The effect of applying these age classes to our models was illustrated in Table 4.9.

By looking only at the range of variance between methodologies used by interviewees (excluding rounding down which was not used by interviewees), (Table 4.14), an average of R 2,617,399 difference in value exists for the six different valuation models. This variation is brought about by a change in weighted average age from 5.97 (achieved through rounding to 0.5 methodology) to an average weighted age of 6.47 (using the round up methodology).

Table 4.14: Difference in valuation per model as a result of a change in age class grouping methodology

Age Class Methodology	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
Round Up	R 31,741,197	R 34,539,834	R 34,626,297	R 38,286,522	R 30,404,238	R 30,784,068
Round to Nearest Whole Number (Default baseline)	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105
Round to 0.5	R 28,784,894	R 31,574,467	R 32,398,343	R 36,132,890	R 27,710,501	R 28,076,671
Difference	R 2,956,303	R 2,965,367	R 2,227,954	R 2,153,632	R 2,693,738	R 2,707,397
% Difference	10.27%	9.39%	6.88%	5.96%	9.72%	9.64%

The standing value model is the most affected by age class rounding with the 8.38% change in average weighted age (from 5.97 to 6.47) resulting in a 10.27% increase in value when round up methodology is used instead of round to 0.5. This difference is partly due to the effect of young timber moving between utilisable and non-utilisable classes. Although the DCF2 and NDSV models are the most significantly affected by a change in age class rounding after the SV model, the DCF1 model is least affected, as this 8.38% change in average weighted age results in a 5.96% change in value, followed by the MAX(CV,SV) model.

Using the data from Table 4.14, the following sensitivity index per model with respect to age class can be calculated (Table 4.15).

Table 4.15: Sensitivity index calculated per model for the effect on model valuation by age class rounding logic

SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0.093	0.086	0.064	0.056	0.089	0.088

Fractional ranking highlights the DCF2 model as the most sensitive to a change to age class rounding logic, whereas MAX(CV,SV) model is the least sensitive, or least affected by a change in the age class rounding logic (Table 4.16).

Table 4.16: Fractional ranking of valuation models where [1] denotes the valuation model most affected by the change in age class rounding logic

	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
Fractional Ranking	1	5	4	6	2	3

4.6.4 Land value

Land value is only included as an input parameter in the CV model. Any changes in land value will thus affect this model directly and the MAX(CV,SV) model indirectly in as far as the CV component of the model will change with land value. The reason why land value is included in the CV model is to account for the cost of the interest on land.

4.6.5 Input (establishment and maintenance) costs

When the input costs (establishment and maintenance) as well as the annual recurring costs are inflated and deflated by 5%, 10%, 20%, 50% and 100% respectively it was found that any change in input costs has no effect on the SV and DCF1 model valuation output. An increase in costs results in an increase in the valuation value for the Cost Value (CV) model. The DCF2 and NDSV models work in the exact opposite way where an increase in costs results in a decrease in valuation value (Table 4.17).

Table 4.17: Model valuation per model and percentage change in input costs

% Change	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
100%	R 29,508,770	R 34,980,504	R 34,989,978	R 36,819,848	R 18,011,306	R 18,393,874
50%	R 29,508,770	R 33,822,922	R 33,863,964	R 36,819,848	R 23,112,422	R 23,494,989
20%	R 29,508,770	R 33,115,588	R 33,180,559	R 36,819,848	R 26,173,091	R 26,555,658
10%	R 29,508,770	R 32,877,978	R 32,963,227	R 36,819,848	R 27,193,314	R 27,575,881
5%	R 29,508,770	R 32,758,861	R 32,854,895	R 36,819,848	R 27,703,425	R 28,085,993
0	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105
-5%	R 29,508,770	R 32,520,039	R 32,637,800	R 36,819,848	R 28,723,648	R 29,106,216
-10%	R 29,508,770	R 32,400,349	R 32,531,767	R 36,819,848	R 29,233,760	R 29,616,328
-20%	R 29,508,770	R 32,160,452	R 32,327,485	R 36,819,848	R 30,253,983	R 30,636,551
-50%	R 29,508,770	R 31,437,213	R 31,757,884	R 36,819,848	R 33,314,652	R 33,697,220
-100%	R 29,508,770	R 30,224,317	R 30,934,933	R 36,819,848	R 38,415,767	R 38,798,335

The CV valuation value is non-linear, and is therefore not directly proportional to change in input cost value. This is because a change in the input costs triggers an automatic re-calculation of the relevant IRR. This auto-correction of the IRR also prevents the CV model from being the most influenced by a change in input costs. The DCF2 and NDSV models' values are linear, and proportional to the input cost value. They are significantly more influenced by a change in input costs than the cost value model. The DCF2 value decreases by 3.62%, and the NDSV model value decreases by 3.57% respectively for every 10% increase in input costs.

The sensitivity index per model (Table 4.18) is calculated based on the data in Table 4.17.

Table 4.18: Sensitivity index calculated per model for the effect on model valuation by input costs

SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0.000	0.136	0.116	0.000	0.531	0.526

Fractional Ranking (Table 4.19) of the sensitivity indexes in Table 4.18 highlights the DCF2 model as the most sensitive in terms of the effect that a change in input (Establishment and Maintenance) costs has on the model value output .

Table 4.19: Fractional ranking of valuation models where [1] denotes the valuation model most affected by input costs

	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
Fractional Ranking	5.5	3	4	5.5	1	2

4.6.6 Harvesting and logistics (mill delivery) costs

When harvesting and logistics costs were inflated and deflated by 5%, 10%, 20%, 50% and 100% respectively, it was found that the SV, DCF1, DCF2 and NDSV models generate negative valuation values for very high mill delivery costs (when these costs have been doubled) (Table 4.20).

Table 4.20: Model Valuation per model and percentage change in harvesting and logistics costs

% Change	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
100%	-R 3,164,737	~R 379,348[a]	~R 659,663[a]	-R 3,304,976	-R 13,761,178	-R 13,378,610
50%	R 13,172,016	R 17,993,109	R 17,993,109	R 16,757,436	R 7,226,180	R 7,608,747
20%	R 22,974,068	R 27,202,215	R 27,224,310	R 28,794,883	R 19,818,594	R 20,201,162
10%	R 26,241,419	R 29,972,017	R 30,019,483	R 32,807,366	R 24,016,066	R 24,398,633
5%	R 27,875,094	R 31,317,467	R 31,387,592	R 34,813,607	R 26,114,801	R 26,497,369
0	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105
-5%	R 31,142,445	R 33,940,057	R 34,092,211	R 38,826,089	R 30,312,273	R 30,694,840
-10%	R 32,776,120	R 35,220,568	R 35,443,726	R 40,832,330	R 32,411,008	R 32,793,576
-20%	R 36,043,471	R 37,726,922	R 38,143,699	R 44,844,813	R 36,608,480	R 36,991,047
-50%	R 45,845,523	R 44,881,265	R 46,600,869	R 56,882,260	R 49,200,894	R 49,583,462
-100%	R 62,182,276	R 55,903,481	R 62,446,495	R 76,944,672	R 70,188,252	R 70,570,819

a: These values are approximations, as IRR could not be accurately determined for Pine compartments.

The results in Table 4.20 can be used to calculate the sensitivity index per model (Table 4.21).

Table 4.21: Sensitivity index calculated per model for the effect on model valuation by harvesting and logistics costs

SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
1.05	0.993	0.989	1.04	1.20	1.19

Fractional ranking (Table 4.22) of the sensitivity indexes in Table 4.21 highlights the DCF2 model as the most sensitive in terms of the effect that a change in harvesting and logistics (mill delivery) costs has on the model valuation output. Again, the CV model is affected by an automatic recalculation of IRR as harvesting and logistics costs change.

Table 4.22: Fractional ranking of valuation models where [1] denotes the valuation model most affected by harvesting and logistics costs

	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
Fractional Ranking	3	5	6	4	1	2

4.6.7 Point of sale (market) prices

To determine what effect a change in point of sale (market) prices has, the market price was inflated and deflated by 5%, 10%, 20%, 50% and 100% respectively (Table 4.23).

Table 4.23: Model Valuation per model and percentage change in point of sale (market) prices

% Change	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
100%	R 59,017,539	R 53,857,976	R 59,322,393	R 73,639,696	R 67,011,872	R 67,394,440
50%	R 44,263,155	R 43,736,929	R 45,320,682	R 55,229,772	R 47,612,705	R 47,995,272
20%	R 35,410,524	R 37,225,263	R 37,656,050	R 44,183,818	R 35,973,204	R 36,355,772
10%	R 32,459,647	R 34,960,292	R 35,188,439	R 40,501,833	R 32,093,370	R 32,475,938
5%	R 30,984,208	R 33,807,279	R 33,961,523	R 38,660,840	R 30,153,454	R 30,536,021
0	R 29,508,770	R 32,639,545	R 32,746,416	R 36,819,848	R 28,213,537	R 28,596,105
-5%	R 28,033,331	R 31,456,217	R 31,525,059	R 34,978,856	R 26,273,620	R 26,656,188
-10%	R 26,557,893	R 30,256,331	R 30,302,896	R 33,137,863	R 24,333,703	R 24,716,271
-20%	R 23,607,016	R 27,802,482	R 27,822,946	R 29,455,878	R 20,453,870	R 20,836,438
-50%	R 14,754,385	R 19,900,969	R 19,900,969	R 18,409,924	R 8,814,369	R 9,196,937
-100%	R 0	R 3,287,876	R 3,287,876	R 0	-R 10,584,798	-R 10,202,231

The results shown in Table 4.23 are exactly the same as those derived for the parameter MAI(t) in Table 4.11. At low market prices the DCF2 and NDSV model valuation values become negative. The change in market price input is directly proportional to the model valuation output value for the SV, DCF1, DCF2 and NDSV models. For every 10% increase in market price the SV, DCF1, DCF2 and NDSV models experience an increase in output valuation value of 10%, 10%, 13.75% and 13.57% respectively.

The sensitivity index per model (Table 4.24) is calculated based on the data in Table 4.23.

Table 4.24: Sensitivity index calculated per model for the effect on model valuation by point of sale (market) prices

SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
1.00	0.94	0.94	1.00	1.16	1.15

Fractional ranking (Table 4.25) of the sensitivity indexes in Table 4.24 highlights the DCF2 model as the most sensitive in terms of the effect that a change in point of sale (market) prices has on the model valuation output.

Table 4.25: Fractional ranking of valuation models where [1] denotes the valuation model most affected by point of sale (market) prices

	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
Fractional Ranking	3.5	5.5	5.5	3.5	1	2

4.7 Chapter summary

This chapter presented the results obtained from data collection through to the analysis of valuation outputs obtained from the collected models. In total, six unique models were collected from seven interviewees.

Model valuations from case study plantation data resulted in 30.5% variation in range between minimum and maximum values from these six models, with the DCF1 valuation model producing the highest, and the DCF2 providing the lowest valuation values. The valuations have been found to be significantly affected by the treatment of different genre and age class. The closer the stand is to fell age, the lower the significant difference is between model value means. It has also been shown that the highest degree of significant difference across model valuations occurs for low yield classes. This means that the most significant difference between valuations will occur when valuations are performed on relatively young low yielding crops. At fell age no significant difference exists.

Methodology used for the determination of yield class was found to have considerable impacts on valuations performed with the SV model, whereas various methods for determining age class were found to affect all models considerably.

CHAPTER 5: DISCUSSION

5.1 Introduction

There is a wide range of factors that influence the market value of forests and as a result a wide variation in values is evident (Askham and Blake, 2003). These factors include long production periods, basic economic data, physical inputs, costs, physical production response, market structure and prices, technological change and the dynamic of the forest ecosystem (Lundgren and Thompson, 1972). Accounting for biological assets, and in particular forest assets, requires a thorough understanding of these factors as well as expertise in forestry, valuation techniques and accounting standards (PWC, 2011). Therefore the analyst's choice of appropriate valuation techniques for a given forestry project calls for sound judgement (Kengen, 1995). This judgement should be based on the fact that the use of different valuation methods and techniques can result in different valuation output figures for the same area (Naskali, 1995) a finding that has been confirmed by this study. Valuations performed on the case study data with the six identified valuation models resulted in a 30.5% variation between minimum and maximum values from the models, with the DCF1 model resulting in the highest value and the DCF2 model the lowest value.

5.1.1 Valuation approaches and methods

Given the variation in valuation results provided by different valuation methods it was not surprising that most respondents interviewed during this study concurred that the selection of valuation model is based upon the reason for the valuation, a finding which is supported by literature (Bullard and Straka, 1993; Kengen, 1995; IVSC, 2012; Ham et al., 2012). The International Valuation Standards Council's (IVSC) framework explains that the choice of the most appropriate approach or approaches, will depend on the purpose for which the valuation is required which in turn determines the required basis of value. The required basis of value will determine the inputs that are relevant and these will then influence the choice of approach or method (IVSC, 2012). A common factor to all approaches and methods used to value forests is the need to reflect the fact that trees mature over time, and that the effect of different states of maturity will need to be reflected in whatever method is selected.

5.2 Valuation models

5.2.1 Short discussion of identified models

Various studies on the valuation methods used by forestry companies have revealed that valuations based on market values, expected future prices and historical cost methodologies exist within the international community (Manley, 2007; PWC, 2009; Bierfreund and Pichlo, 2013). Within the model collection phase of this study the use of the historical cost model for valuation purposes was not encountered. Instead, owing to the relatively short rotation periods (typically between 5-20 years) companies operating within South Africa tend to use current market prices for valuation purposes (PWC, 2009).

While the CV (or derived Faustmann formula) method is mostly favoured by professional valuers and seen as a generally accepted valuation method for South Africa (Uys, 1997) the DFC valuation method is favoured by forestry companies both in South Africa and Internationally, for fair value determination (Manley, 2007; PWC, 2009; Bern and Johansson, 2010; PWC, 2011; Bierfreund and Pichlo, 2013; SAFCOL, 2013; SAPPI, 2013; York, 2014; Mondi, 2014). Studies based on the financial statements of international IFRS compliant forestry companies revealed that NPV arrived at by DCF modelling is by far the most common method of determining fair value (Manley, 2007; PWC, 2009). Bierfreund and Pichlo (2013) conclude that the widespread use of DCF models might be due to the possibility to control the valuation in the financial statements to a certain degree, by adjusting the input variables.

5.2.1.1 Standing value method

SV is the method most favoured by IAS 41. It requires that agricultural produce be measured at its fair value less estimated point-of-sale costs at the point of harvest (IAS 41, 2011). SV is only partially used by one of the interviewees, in the form of the MAX(CV,SV) model. The main problem identified regarding the use of the SV model is that while there might be an active market present, tree dimensions in the case of young or very old trees could exclude age groups from this market (Ham et al., 2012), thereby making standing value an unrealistic valuation method.

Advantages of this method are that costs are current, factual and objective and can be substantiated in court. One of the interviewees observed, however, that the SV method does not account for is poor silviculture and costs to rectify this, like weeding, de-stumping and replanting costs, and it also does not account for annual costs and overheads.

Owing to the use of current prices and costs, the stumpage method has no better alternative for marketable timber valuation. It does however have limited use in valuations for under aged timber with no marketable volume, such as where timber does not fit required market specifications (Davis et al., 2001; Nunamaker et al., 2007; IVSC, 2012).

5.2.1.2 Cost value method

Valuation based on the CV methodology is also well recognised within the South African forestry sector. This was confirmed by literature (Marwick, 1993; Uys, 1997; Ham et al., 2012) and by the seven interviewees who use this method. One of the main advantages of the CV method is that it does not make use of a discount rate. Instead an IRR is used. This IRR is a function of the method and therefore it cannot be manipulated or disputed.

The disadvantage of this method is that cases may be encountered where an IRR cannot be accurately determined for a project. As the IRR is the discount rate at which the NPV of an investment becomes zero (Bettinger et al., 2009), scenarios can exist in which no IRR exists that will cause an NPV to become zero. This may occur within projects where the NPV is always negative i.e. when input costs are greater than the value of the sellable timber (Schmidt, 2004).

5.2.1.3 MAX(CV,SV) method

Plantation value can only be accurately determined at two points within a rotation (Marwick, 1993), namely:

- Using the cost of establishment at time of planting.
- Calculation of volume and log class distribution as well as stumpage prices at time of felling.

The MAX(CV,SV) method accounts for both of these accurately determinable values at the points of establishment and felling. The advantages of this method are as follows:

- For utilisable timber the market value is used in deriving its value, and is therefore (according to IAS 41) the most accurate value.
- The cost value component of this method covers age classes where no utilisable product can be physically recovered.

In effect this method overcomes the problems pointed out previously regarding the SV and CV methods. CV is generally greater than SV for immature timber, and provides a realistic replacement value for newly established stands. SV (most favoured by IAS 41) on the other hand is generally a more accurate determination of value for mature timber, and usually provides a higher value than CV as the stand approaches maturity.

Besides providing realistic and defendable values through the full growth cycle of the stand, both the components of this method are recognised, well-established and well documented valuation methods within the industry (Ham et al., 2012). Furthermore both the SV and CV component calculations will result in comparable answers, as these methods do not make use of an interest rate, and cannot be manipulated in order to achieve a desired output. The only manipulation possible within the SV and CV models will be in the form of manipulation of the input parameters used to calculate IRR.

5.2.1.4 Discounted cash flow method

While DCF methods are recognised in forestry valuation (IVSC, 2012) and compliant with IAS 41 (PWC, 2009; PWC, 2011) it was found that the three DCF models collected for the purpose of this thesis vary from each other both in calculation mechanisms as well as within the calculation outputs obtained from them. They account for the highest and lowest valuation values, and therefore are responsible for the 30.5% variance encountered between models. Within this study it was found that only the DCF1 model makes use of a risk premium, but does not incorporate establishment and maintenance costs. Although the DCF2 and NDSV models make use of the same input parameters, only annual overhead costs are used in the calculation of NDSV, whereas DCF2 makes use of total expenditure. The DCF1 model uses SV for mature stands or future expected volume for immature stands to determine the current value. DCF2 and NDSV discount the future expected volume at the fell date to the present to get the current volume component

The collection of three DCF models with different mechanisms is consistent with findings from literature, which suggests that there are many variations when it comes to what can be used for cash flows and discount rates in a DCF analysis (Shim and Siegel, 2008; Häcker and Ernst, 2011). Using DCF to determine the fair value of biological assets has raised concerns regarding the assumptions used in the DCF method (IVSC, 2012). The assumptions are often determined by the accountants or consultants and understandably, assumptions are likely to vary between companies and between countries (Kamaruzzaman and Erlane, 2013). Regarding the use of DCF in the valuation of firms Kruschwitz and Loeffler (2005) indicated that if the theory does not provide an answer, practitioners are left with no choice but to make ad hoc adjustments to the valuation equations according to their judgement, concluding that for the practitioner the theory can only be a guideline. However true this may be, it has been shown that slight shifts in judgement concerning one or more variables relevant for the DCF model to measure forestry assets, and small changes in input, can have significant impacts on financial statement (Macedo, 2012; Shim and Siegel, 2008).

Another issue raised regarding the use of the DCF method is the selection of different discounted rates used in the calculation of the present value of future net cash flows. Here it is necessary to ensure that the discount rate is consistent with the valuation method and with the definition of the cash flows to be discounted (Häcker and Ernst, 2011). Different discount rates used by different companies and geographical regions raise concerns regarding the comparability and verifiability of financial statements between companies and countries (Dvorakova, 2006; Aryanto, 2010; Thurrun-Bakir, 2010).

Another finding regarding the use of DCF models is the negative values calculated for low yield classes and young age groups, as is the case for the DCF2 and NDSV model calculations within this study. While negative valuation results are counter-intuitive it is possible that the outcome of a DCF-based valuation can be negative. This can occur when the discounted expenditure is greater than the discounted revenue, and is most likely to occur in the initial years when a low value product has a low growth yield. The problem can also be exacerbated when relatively high establishment costs are required. This was especially notable during the 20th century, when timber prices in many countries eroded in real terms whilst the costs for forest operations steadily grew (Wagnière, 2011). When queried about how negative values would be handled, the DCF2 model owner indicated that these negative values may result in a decision to use an alternative method, or a relook at the interest rate being used.

Discounted cash flow models are powerful, but they do have shortcomings. The DCF method has been described as being inherently subjective and may provide opportunities for manipulation (Dvorakova, 2006; Thurrun-Bakir, 2010). It can be argued that the fair value determined by the DCF method may not reflect the true fair value of the biological assets (Kamaruzzaman and Erlane, 2013). Shim and Siegel (2008) point out that the DCF is merely a mechanical valuation tool, which makes it subject to the axiom "garbage in, garbage out".

5.3 Analysis of valuation difference between models

5.3.1 Genus / model comparison

Model valuations have been found to be significantly affected by genus (chapter 4.4.1). This is expected because compartments of differing genera are subjected to differing treatments, including differences in growth factors (MAI), input costs (establishment and maintenance costs), harvesting costs and market prices. The different genera are also subjected to different rotation periods. Between genera, it was found that harvesting costs, growth factor, market price and rotation length accounted for the majority of the significant differences between model valuations. This result correlates with the sensitivity analysis findings, where harvesting costs, growth factor and market prices were found to be the most influential model input parameters after age class rounding (chapter 4.6).

Within the case study data, it is therefore not surprising to find that less significant difference is found between model valuation means for wattle. This is due to its high market price or stumpage value (R 340.71/tonne, which includes the wattle bark component). The high degree of significant difference found between model valuation means for pine can largely be explained by the relatively low stumpage value of only R 96.67/tonne, and the longer growth cycle (16 years) which result in significantly lower valuations from the DCF based models, and a significantly higher CV model valuation, therefore resulting in a greater variance between models.

Despite the relatively high market price (R 236.32/tonne) and low rotation age (10 years) for eucalypt, the large amount of variance found between the model valuation means is largely due to the wide range of variation between the seven yield classes (MAI ranges from 10 to 24) resulting in the wide range of calculated IRR's (0.06% for G.7 to 8.44% for G.1).

The DCF1 model (having the highest mean value of the DCF based models), is most often elevated well above all other models in terms of its mean and significant difference. This is largely due to the relatively high value given to young stands by the DCF1 model as seen in figures 4.8-4.13. Just after a stand is planted, the DCF1 model assigns the discounted future value to the stand, even though no utilisable volume exists. This discounted future value is usually much greater than values derived by other models, including the cost value model. This finding is supported by Mayo and Straka (2005) who confirm that the present value derived from discounting the net harvest revenue of future merchantable timber usually exceeds the current-use value of the timber. This is because pre-merchantable timber stands contain no timber products that can be sold today, and immature timber stands lack the product size and quality to warrant the higher unit prices of mature timber

There is no significant difference between the DCF2 and NDSV models for the pine and wattle data. These two models have been shown to share the same underlying mechanics. The same applies for the CV and MAX(CV,SV) models, being not significantly different for pine and wattle data, where the MAX(CV,SV) model uses the CV model as one of its components.

What is surprising is that even though the DCF1, DCF2 and NDSV models are all forms of discounted cash flow, the DCF1 model has been shown to be significantly different to the DCF2 and NDSV models for pine and eucalypt even when the same interest rate is applied. This is because the mechanics of the DCF1 model are very different to those of the DCF2 and NDSV models, which both make provision for operational expenditure (by subtracting discounted expenditure), while the

DCF1 model does not account for any costs. In most cases, the DCF1 and DCF2 models form the upper and lower limits in terms of the variance analysis performed within this study.

5.3.2 Analysing the output differences between age classes

Each of the six collected models gives the same valuation answer for stands at fell age (as illustrated graphically in Figures 4.5, 4.6 and 4.7 in Chapter 4) but differed significantly in their values for younger age classes. This is ultimately due to the variance in the calculation of utilisable timber volume (by each valuation model) for immature timber. It has been shown that as the age approaches fell age (for all genera) the model output values converge to the same point, so that at fell age all models calculate the exact same output value and there is no significant difference between model valuations. This is because at fell age all the market variables are known and values can be accurately determined through the standing value calculation. All models make use of this stumpage value at fell age as the culmination point of their model valuation value. The choice of model is thus irrelevant for the valuation of timber at fell age as all models determine the same result. In this way Marwick's finding (1993) that volume and stumpage prices can be accurately determined at time of felling is confirmed.

The greater variance between model valuations is observed for immature plantations (Figures 4.5, 4.6 and 4.7). This is illustrated throughout the analysis and can be explained through the analysis of the mechanics of each model. At a point in time soon after establishment has taken place the SV is zero, as the utilisable volume is zero, whereas CV will account for the cost of the establishment process. The further a stand is from fell age the more the discount rate plays a part in the variation between values for the DCF models. Bullard and Straka (1993) have highlighted the problem encountered where immature timber has value, but by definition has no current potential for conversion to timber products. It is argued that immature timber's value can also be represented by its temporal progression towards mature commercial timber. Primarily, this value results from the sunk cost of stand establishment and the opportunity cost of holding land to grow trees (Bullard and Straka, 1993). Sensitivity analysis by Klemperer (1987) for DCF specifically confirms that valuation factors for young timber can vary widely, depending primarily on real interest rates and future stumpage price expectations.

5.3.3 Analysing the output differences between yield classes

Differences were more significant between valuation model means for low yield classes. Input costs (e.g. establishment and maintenance costs) are equal and remain constant per genus across yield classes. Higher yield classes result in higher volumes of product (yield) and therefore higher model valuation values per model.

The mechanics of the valuation models are primarily based upon the value of the standing timber at fell age (Z), the costs of producing a merchantable stand (C), or a combination of these two factors (Z-C). Under normal circumstances, the value of the standing timber at fell age is much larger than the associated costs, which ensures a profit is made. When Z is significantly greater than C, then models based upon Z and (Z-C) are expected give similar outputs. As C increases, so will the variance between model valuations.

With relatively high stumpage values for eucalypt and wattle, low yielding classes are seen to result in only slightly more significantly different valuation means. For pine, with a very low stumpage value and long rotation length, low yield classes show much greater significant differences between model valuation means, than the high yield classes.

5.4 Identified parameter findings

The selection of the valuation model is key to determining which input parameters are required but there is no documented list of what information is needed (Kengen, 1995). Furthermore the information required will depend on the objective of the valuation, the context in which the valuation is being carried out as well as availability, time and cost to collect information and the technique/method used. The difficulty of timber valuation is further compounded by the potential significance that each of the required input parameters has on the end value (Marwick, 1973). Key assumptions can be affected by geographic location, silvicultural practices, type of forest, rotation lengths and species. These in turn drive different modelling assumptions (PWC 2011). Various methods of timber classification (for example, by age and/or species) are used within the industry, and these variances are acceptable as IAS 41 does not provide guidance regarding this issue

(PWC, 2009). Provision is specifically made for the variance in the determination of the age class and quality (yield class, or MAI) within IAS 41 (IAS, paragraph 15, 2011).

5.4.1 Discount rate

The choice of the discount rate is one of the most important problems in investment analysis because the discount rate considerably affects the magnitude of the calculated value, and is one of the factors which the NPV-based valuation is most sensitive to (Greìe-Staltmane and Tuherm, 2010; IVSC, 2012). The results of the sensitivity analysis performed within this study conclude that interest rate only affects the discounted DCF based models. Age class rounding, harvesting costs, market prices and yield class all rank higher than discount rate in terms of the effect that a percentage change to the input parameters has on the percentage change of the output valuation. The DCF2 model being the most sensitive to interest rate, requires a 24.47% decrease in interest rate (from 7.6% to 5.74%), in order to achieve a 10% increase in the model generated plantation valuation value.

Despite this finding, it has been acknowledged by interviewees using DCF based methods, that interest rate is the most likely parameter to be manipulated in order to achieve a predetermined valuation outcome. This is likely because of the freedom that exists in determining an interest rate within the IAS 41 framework. No single discount rate for forestry investments exists, instead a series of discount rate approaches offers different discount rate estimating options and none of them is universally applicable (Greìe-Staltmane and Tuherm, 2010). Some valuers select discount rate primarily on the basis of current industry practice using information from previous surveys or from other valuers (Manley, 2007). Klemperer (1996) points out the lack of uniformity in the use of the discount rate, as one investor may conservatively project no stumpage-price increase and use a low-risk discount rate while another may project optimistically high prices using a large discount rate to reflect the resulting risk. In many cases buyer's and seller's values are determined using different interest rates, but even if the same interest rate is used, inconsistent results may occur (Bullard and Straka, 1993). This has been the case within the scope of this study, with all three DCF models (DCF1, DCF2 and NDSV) providing different values while using the same interest rate.

Researchers have investigated the possibility of standardising the way in which interest rates should be determined. Bright (2001) valuates forestry as a long-term investment and suggests that when choosing a discount rate in forestry, the long-term yield from company shares or government securities should be taken into consideration. Another approach pointed out by Greìe-Staltmane and Tuherm (2010) is to add a two or three percentage-point risk premium to the average real risk-free long-term government bond interest rate. This approach is used in the DCF1 valuation model.

In 1999 the European Framework for Integrated Environmental and Economic Accounting for Forests (EFIEEAF) published the notion that the discount rate be equal to the value growth rate of standing timber (European Commission 1999). In this scenario higher interest rates may apply only if future timber prices are expected to increase. Bullard and Straka (1993) make a case for the IRR to be used as the appropriate rate for immature stands. Within this study it was found that the CV model makes use of a calculated IRR per project (in this case per yield class) and is therefore not affected by the selection of an appropriate discount rate in any way. As discussed previously SV does not make use of a discount rate of any kind. CV makes use of an IRR which is informed by the output of the SV model value at fell age.

5.4.2 Input yield difference (MAI)

Forest growth models attempt to quantify the growth of a forest, and are commonly used to predict the future status of a forest and the nature of any harvests from that forest (Vanclay, 1994). Much research has gone into the development of growth and yield models over many years, with the purpose of providing more accurate predictions for stand yields at any point within the plantation lifecycle (Buckman, 1962; Clutter, 1963).

The possible variance between valuation values based on straight line MAI versus those determined by growth models has been discussed in chapter 4.5.1. It was found that there is a significant difference in volume and value between the two calculation methodologies (12.1% difference in the case of SV, resulting in just over a R5 million difference). The selection of growth model MAI versus straight line MAI has a significant effect on the calculated volumes, and therefore on the valuation output, especially for young and newly planted trees. The growth model yield curves presented in chapter 4.5.1 seem to more accurately account for the lack of utilisable timber at younger ages, whereas the use of a straight line MAI at younger ages would imply that utilisable timber could be recovered from a one year old compartment, albeit very little.

Despite the availability of growth models and the fact that using a straight-line MAI method to construct the yield curve would lead to over-estimates of standing volume when compared to non-linear models (Kotze, 2015) the majority of interviewees confirmed that they use a straight line MAI for valuations. IAS 41 does not cover use or not of growth models (IAS 41, 2011). Reid et al. (1999) confirms that the use of straight line MAI is widely used (and abused), and warns that such use of MAI should only take place when the stand age is known. Lutz (2011) confirms the use of straight line MAI by foresters when describing tree growth, but shows that trees do not grow at a constant rate. Marwick (1973) made the point that growth is not linear through the year, with the majority of growth occurring during the summer months, and advocates that linear interpolation between full years to obtain the value for a particular month is incorrect.

When questioned about the preference of straight line MAI, some interviewees (mostly valuation consultants) responded that in most cases it is because growth model data is not available. Interviewees also acknowledged that use of growth models could be limited due to cost implications and possibly relevance (such as in the case of small farms). Most of the valuation model users (interviewees) that participated within this study have a financial (accounting) or property valuation background, and not a forestry background. The responses from interviewees highlight the possible lack of skills and expertise required to use growth models successfully. In this regard Herbohn and Herbohn (2006) point out that sophistication of internal management information systems is required for the development and application of growth models. Elad (2004) argues that due to this the use of growth models has the potential to cause implementation bottlenecks in developing countries.

5.4.3 Age class

Three different methodologies of age class grouping have been identified from the data collection process (see chapter 4.5.2). All methods for calculating age class grouping are accepted, as IAS 41 does not stipulate a method for doing so. The resulting possible variance from different age class calculation methodologies has been discussed in chapter 4.5.2, and analysed through sensitivity analysis in chapter 4.6.3. It has been shown that all of the model valuations are affected considerably by the effect of age class rounding (Table 4.14) where the effect in rounding ("round up" versus "rounding to nearest 0,5", and "round to nearest whole number" methodologies, as used by the interviewees) presents an average difference in valuation of just over R2.6 million for the six valuation methods.

Sensitivity analysis has shown that valuation models are more sensitive to age class rounding than any other input parameter. It can be concluded that age class grouping methodology can be a significant contributor to the variance between two valuations based on different age class calculation methodologies. Marwick (1973) supports this finding by highlighting the significant effect of using an actual age versus an age class to determine the value of a compartment. He further points out that age should be used to the nearest month, because the age and value have a close bearing on each other.

Other methodologies of age classification that were not encountered include the use of "actual age to the nearest decimal" and "rounding down". Although rounding down would provide less volume, and therefore less standing value, this could be used to lower the overall plantation value, possibly for tax evasion purposes. If Marwick's (1973) proposal of using age rounded to the nearest month was implemented, the possibility of using age class rounding to manipulate overall value would be eliminated. This would also remove any ambiguity regarding the use of this parameter by any valuing party. One of the consequences of performing a valuation using this age class methodology would be that the valuation would only be valid for the month in which it is calculated.

5.4.4 Land value

Within this study only the CV model and consequently the MAX(CV,SV) model, are affected (and only slightly) by land value. This change can be attributed to the gain or loss due to interest payable on the land (Ham et al*.*, 2012). This interest is handled as an annual cost and is therefore also used in the calculation of, and affected by the IRR. The lower the IRR the less effect land value will have on the CV valuation.

5.4.5 Input and mill delivery costs

When dealing with costs as an input parameter, it would seem reasonable to assume that the CV model would be most affected by changes in costs. However results related to the sensitivity analysis of changes in costs (establishment, maintenance) reveal that the DCF2 and NDSV models are more affected than the CV model. The reason for this is the re-calculation of the IRR within the CV model when the input parameters are changed (Jeffery, 2004). Without this recalculation of the IRR, the CV would be the most influenced by changes in input costs. All models are significantly impacted by harvesting and logistics costs, with the CV model being least affected

By doubling the harvesting and logistics costs it has been shown that valuation values can become negative, resulting in the SV, DCF1, DCF2 and NDSV models producing negative valuations. In this scenario the MAX(CV,SV) model prevents a negative valuation. However it is reasonable to assume that the negative value is in fact the correct answer, as the equivalent real world scenario would result in a loss.

In South Africa there is an established wood market. Due to this it is relatively easy to obtain a market price for the wood products. The lack of active markets has been cited as a possible reason for the preference of the DCF models in other parts of the world (PWC, 2009; PWC, 2011). In South Africa however, most large forestry corporates have chosen to persist with DCF based valuation models for the purposes of financial reporting, despite the presence of an active market.

5.4.6 Point of sale (market) prices

There is a strong degree of vertical integration with downstream sectors in the South African forestry plantation sector. Plantation owners tend to be significant secondary producers of timber products, as seen with Mondi and Sappi in pulp and paper, PG Bison in fibreboard, as well as York and Hans Merensky in sawn timber (Pogue, 2008). The major paper and pulp enterprises (Mondi and Sappi) effectively span the value-chain from the renewable resource sector (plantation forestry), to primary processing (pulp milling) and through to secondary beneficiation (paper and paper products). As a result of this vertical integration, it can be argued that the "market price" can effectively be manipulated by these large forestry corporations. IAS 41 (2011) defines an active market as having homogeneous items traded, having willing buyers and sellers (normally found at any time) and using prices that are available to the public. Within the pulp wood market, (on which this study is based) there are at least four buyers within South Africa, (Mondi, Sappi, TWK and NCT). These multiple buyers of pulp wood ensure that an open active market exists within South Africa.

5.5 Sensitivity analysis

The sensitivity analysis indicates that the age class rounding is the most significant parameter for the SV and CV models, with an 8.38% change in age ("rounding up" and "rounding to the nearest 0.5" methodologies) resulting in a 10.27% change in valuation for SV. Age has also been found to affect all models considerably. These results confirm that the determination of age has a significant impact on the bottom line value, as pointed out by Marwick (1973).

Harvesting costs were found to be the most significant factor for all of the DCF based models, as well as for the MAX(CV,SV) model, followed by growth factor (MAI) and market prices. All three of these input parameters affect all models considerably. Sensitivity analysis also shows that growth factor and market price have the exact same affect on all models. This can be explained by the fact that all models base their values on the SV (SV model), or on the SV at fell age (CV and DCF models). SV is derived from price x volume. Therefore if the volume is increased by 10% (through a 10% increase in MAI), or the market price is increased by 10%, the affect on the SV is exactly the same. Literature confirms that timber price assumptions are fundamental in estimating fair value (PWC, 2009). Sensitivity analysis of variables using DCF methodology by Klemperer (1987) reveals that the timber valuation factors are highly sensitive to assumed rates of stumpage price increase and capitalization rates.

5.6 IAS 41 compliance

The opponents of fair value accounting argue that fair value comes at the expense of reliability since fair value must be established using valuation techniques that require assumptions (Penman, 2007; Benston, 2008). Vague formulations in accounting standards or the lack of regulations for special cases have also been raised as factors that might lead to interpretation and application issues. This could cause preparers to develop own best practices (Norman, 2012). The actions of interviewees in this study have confirmed this. They have been found to use different valuation models, as well as different methodologies in the determination of compliant input parameters. Of their own accord they have determined which valuation models or input parameter classifications are deemed to be best practice. Age and yield class classifications are examples of this.

5.7 Conclusion

With such significant variation between the six models sourced for this study, it seems that the argument raised by Herbohn and Herbohn (2006) regarding the high subjectivity in the measurement of fair value has been substantiated by the findings within this study. The IVSC (2012) acknowledges that it is common practice for the preferred valuation approach to change as a forest matures due to physical and economic changes. It also acknowledges that all valuation approaches have shortcomings, but iterates that a change in the approach or method used does not justify a change in value. The warning is given that the application of IAS 41 Agriculture within forestry could allow those operating within the parameters defined by the requirements of the IFRS some degree of freedom to change the fair value of their standing timber and of disclosing information on significant assumptions. This study has bolstered the arguments that the lack of stringent and clearly defined methodology within the IAS 41 framework could allow manipulation of FV accounting to serve the best interests of the valuating entity (Herbohn, 2005; Herbohn, 2006; Herbohn, 2009).

Many studies have been undertaken around the topic of variability from valuations and financial reporting of plantations (Kengen, 1995; Bierfreund and Pichlo, 2013; Kamaruzzaman and Erlane, 2013). Grege-Staltmane (2010) makes the point that accounting and valuation guidelines are still lacking. He acknowledges that IAS 41 is an attempt to improve the situation and harmonize financial reports, but based on observation from the practice of international forestry companies concludes that a lot of improvement is still needed. The IVSC (2012) recommends the use of different approaches as a cross check to help validate the result of the preferred approach. It is proposed that careful cross checking and reconciliation will help ensure that the method given most weight is the one that market participants would use in order to price the forest. Kengen (1995) concludes that valuations should be case specific with each case having its own specifications and data requirements.

In contrast to these arguments, many recommendations have been made regarding possible solutions which create a form of true standardisation and which will result in greater conformity. This would make comparability possible. Bierfreund and Pichlo (2013) conclude that the accounting for standing trees under IAS 41 shows potential for improvement in practice. Grege-Staltmane (2010) indicated that despite the introduction of several improvements, the IAS 41 still has many gaps e.g. what kind of timber prices would be advisable to use in the calculations and from which age the trees could be considered as a mature plantation etc. As valuation of forest properties is much demanded, a completely independent, international and specific valuation methodology of forest properties should be developed. Aryanto (2010) concluded that there is a need to clarify the accuracy of the concepts under IAS 41. These studies suggest a need to recognise, formalise and standardise the format and collection of input parameters, as well as the way in which this data is used in order to provide truly comparable results. Some studies have already resulted in new model proposals. Svensson et al. (2008) have developed two new methods, the "Immediate Harvesting Method", and the "Decomposed Real Estate Method". Both approaches achieve a higher level in the hierarchy of IAS 41 than the present value of future cash flows. Kamaruzzaman and Erlane (2013) concluded that there is a need to develop a uniform fair valuation model. It would need to be reasonably reliable in determining the fair value of biological assets, and would ultimately need to benefit all stakeholders and promote better corporate governance by the plantation owners.

This study has confirmed that many IAS 41 compliant valuation models are available within the South African forestry sector. Furthermore the range of valuation results from these different models is considerable. DCF models have been shown to be the most susceptible to manipulation specifically through the discount rate, a parameter used exclusively by DCF based models. Apart from this parameter (discount rate), and the land value which has been shown to have only a negligible effect on the CV and consequently on the MAX(CV,SV) model, the remainder of the input parameters are shared by all models. If it is not possible to remove the requirement for a discount rate completely, then the determination of a discount rate based on an auditable, publically accessible base rate (such as a government bond rate) needs to be enforced. Furthermore the method of calculation of the final discount rate (where the WACC method is currently the most common) needs to be standardised. This should also eliminate the complexity of having to determine whether a pre or post tax rate is to be calculated.

The findings per model used within this study are summarised in Table 5.1.

Table 5.1: Summary of positive and negative elements per model used within this study

Model	Positive	Negative
DCF (relevant for DCF1, DCF2 and NDSV models)	• Used worldwide, well known in the field of accounting.	• Extra input parameter used (discount rate). • No standard method for performing DCF. • No standard methodology for determining discount rate. • DCF models have been shown to be the most susceptible to manipulation, specifically through the discount rate.
CV	• Court approved • Standard calculation methodology	• Extra parameter (land value) used to account for the cost of interest on the land. • SV at ages approaching maturity are more accurate.
SV	• Most accurate method for determining value where market exists for product • Defendable in court • Standard calculation methodology	• Provides no or little value for trees for which there is no market • Unrealistic replacement value for immature timber
MAX(CV,SV)	• Realistic, defendable values for both young and mature trees • Valid replacement value • Standard calculation methodology for components • Component calculations defendable in court	

CHAPTER 6: CONCLUSION

6.1 Study purpose

The purpose of this study was to gain an understanding of the possible variance between IAS 41 compliant valuation models used within South Africa. The findings showed that although all companies are compliant with IAS 41 regulations, the industry does not have an agreed method for financial valuation. It has also been identified that there is a consensus in the industry regarding the need for a uniform method that provides consistent, comparable valuations.

Within this study, IAS 41 compliant valuation models relevant to the South African Forestry sector were collected. It was shown from the collected models had significantly different answers for the valuation of the same theoretical plantation can be generated. The effect of input parameters on the output valuation has been analysed. This study has highlighted the considerable effect that a misinterpretation or manipulation of just one of the input parameters can have on the resulting valuation.

6.2 Findings

There are a number of valuation models being used within the industry. Six unique models were identified for the purpose of this study (Chapter 4.2). Using standardised parameter inputs, the three unique DCF models were shown to provide three unique output values differing in valuation value by a range of 30.5%. Yield and MAI classes were identified as parameters which were being interpreted and used differently by model owners. These significantly affected the variance between model valuation output variances. As a result it is clear that the lack of stringent and clearly defined methods for the treatment of input parameters within the IAS 41 framework, is a source of error with regards to uniformity within valuation calculations.

In South Africa it seems that a standard methodology for valuation is required. This need was identified by the majority of interviewees. From literature reviews and interviews it has been established that DCF is currently favoured by most corporate forestry companies, both locally and internationally, while the CV model is largely favoured by independent valuation consultants locally. There is a large degree of variance between the mechanics of the collected DCF based models, and possibly more so within the determination of an appropriate discount rate. Discount rate has been determined as the parameter most likely to be manipulated in order to achieve a pre-determined valuation outcome. Where utilisable volume exists, and where all costs are known with certainty, the SV generates a value more likely to be realised. This is because the SV value is based on market related real time inputs. SV is a documented calculation and the only way in which the output valuation can vary between users would be due to the differences in determining the input parameters. If the process used for the determination of input parameters were to be standardised, manipulation of the model to achieve a desired outcome would be very unlikely. Although no SV was collected from any of the interviewees as a standalone valuation model, all interviewees were well versed with the calculation of SV. In determining the value of immature timber the shortcoming of the SV model is primarily where no or very little utilisable volume exists in a stand. In this case the CV, based upon a site and project defined IRR, provides a more realistic replacement value.

6.3 Recommendations

The following recommendations are based on issues identified in the study:

6.3.1 Selection of a South African IAS 41 compliant valuation model

It would be in the interest of the South African Forestry Industry to use a standardised valuation model that is practical in South African conditions. In determining a standard valuation model to be used, it is important to consider that this valuation model should be utilisable for all of the possible scenarios in which a valuation is required. This would include valuations for the purpose of sales, purchases, financial reporting, collateral, capital taxation, insurance or compensation, and forest planning and management.

South Africa has an active pulp wood market. Therefore relevant cost and market prices can be collected with relative ease. The SV model is most favoured by IAS 41 (Ham et al., 2012) and provides an accurate and defendable valuation for mature timber as all inputs can be validated. Owing to the active market there is no reason why this method cannot produce a value based on IAS 41 recommendations. This method has however, been shown to be ineffective for the valuation of immature timber as immature timber has little or no value. CV on the other hand, provides a valuation that has been court approved, and provides a realistic replacement value for immature timber. Both the CV and SV models do not make use of a calculated discount rate, which has been determined as the parameter most likely to be manipulated in order to achieve a pre-determined valuation outcome.

Bearing this in mind, and considering all of the valuation models encountered during the duration of this study, the MAX(CV,SV) model appears to be the best suited for all of the purposes outlined above. It is comparable with all models as age approaches fell age, but provides a realistic replacement or compensation value for young aged stands. It cannot be manipulated by an engineered discount rate, it provides a realistic replacement value, and thus a realistic value for immature timber, and is defendable at any point within the growth cycle of the plantation. It is therefore recommended that the MAX(CV,SV) model be used as the standard valuation model within South Africa.

6.3.2 Standardisation of input parameters

Forestry companies around the world interpret the IAS 41 differently (Grege-Staltmane, 2010). More stringent rules and guidelines need to be implemented before uniformity in the use of this standard will be realised within the forestry sector. Furthermore the detail of how this framework is to be implemented needs to be scrutinised, and guidelines put in place regarding the use of each of the input parameters that are used within the fair value calculation, as well as the method in which these values are calculated or approximated.

Regarding the use of age, the framework approves the grouping of age classes, but does not regulate how this is to be done. Sensitivity analysis in chapter 4.6.3 resulted in a 10.27% change in output value (calculated for the SV model) due to a change in age class methodology ("round up" versus "round to nearest 0.5" methodology). If actual age (e.g.: 3.1 years, instead of 3.0 or 3.5) is used instead of an age class calculation mechanism which makes use of rounding, then the input parameter used for age cannot be disputed. The calculated result will however only be valid for the month in which it has been calculated. This is because a calculation for the same stand the following month will use an age that is fractionally higher (3.2 as opposed to 3.1 years old).

Yield tables generated by growth models should also be used, as it has been shown that straight line MAI's tend to over predict yield, especially at ages where timber is immature. Again sensitivity analysis has shown that straight line MAI based valuation calculations result in as much as 12.09% greater value than those based on a growth model (using the Standing Value model). Market prices need to be stipulated as being sourced from an open market, and not from a market controlled by the valuation owner.

Stringent guidelines regarding parameter inputs, including the treatment of ages and the use (or non-use) of growth models for the determination of yield (MAI) should be implemented. This is in order to prevent the possible manipulation of these input parameters, and promote the comparability of results.

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APPENDIX 1: PLANTATION DATA

Table 1: Case study plantation compartment register

Compartment attribute data						Valuation model values per compartment (R)					
Compt	Genus	Species Group	Yield Class	Age	Area	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
C001	P	Ppat	P.2	2.95	7.2	R 52,202	R 102,288	R 102,288	R 108,832	R -3,995	R 3,843
C002	P	Ppat	P.2	4.96	26.9	R 325,053	R 494,033	R 494,033	R 470,762	R 100,401	R 116,051
C003	G	Egra	G.4	7.16	7	R 185,275	R 186,808	R 186,808	R 196,787	R 177,561	R 180,111
C004	G	Eoth	G.4	9.41	12.8	R 435,585	R 436,166	R 436,166	R 435,585	R 428,619	R 428,619
C005	P	Ppat	P.2	4.96	2.6	R 31,418	R 47,750	R 47,750	R 45,501	R 9,704	R 11,217
C006	G	Egra	G.4	7.16	12.8	R 338,788	R 341,592	R 341,592	R 359,839	R 324,682	R 329,345
C007	G	Egra	G.4	3.00	6.6	R 74,866	R 94,928	R 94,928	R 138,418	R 85,625	R 87,419
C008	G	Egra	G.4	8.00	25.4	R 768,324	R 774,566	R 774,566	R 768,324	R 738,481	R 748,437
C009	G	Edun	G.3	0.76	9.2	R 0	R 80,408	R 80,408	R 187,484	R 79,382	R 98,371
C010	G	Egra	G.4	3.96	29.8	R 450,710	R 514,534	R 514,534	R 672,477	R 469,051	R 477,765
C011	G	Egra	G.4	5.96	31.8	R 721,438	R 744,523	R 744,523	R 830,832	R 697,040	R 707,806
C012	G	Edun	G.3	2.64	9.8	R 125,061	R 148,906	R 148,906	R 231,221	R 154,878	R 157,542
C013	G	Edun	G.3	2.74	16.3	R 208,009	R 247,671	R 247,671	R 384,582	R 257,604	R 262,034
C014	G	Edun	G.3	2.74	16.6	R 211,837	R 252,229	R 252,229	R 391,660	R 262,345	R 266,856
C015	G	Edun	G.3	3.33	18.8	R 239,912	R 285,657	R 285,657	R 443,567	R 297,114	R 302,223
C016	G	Egra	G.4	1.94	8	R 60,498	R 92,954	R 92,954	R 155,929	R 79,496	R 85,241
C017	G	Edun	G.3	2.00	1.3	R 11,060	R 15,740	R 15,740	R 28,506	R 16,338	R 17,271
C018	G	Egra	G.4	4.13	2.9	R 43,861	R 50,072	R 50,072	R 65,442	R 45,646	R 46,494
C019	G	Edun	G.3	1.75	20.7	R 176,106	R 250,629	R 250,629	R 453,899	R 260,146	R 275,011
C020	P	Ppat	P.2	9.41	3.6	R 78,303	R 92,268	R 92,268	R 84,450	R 49,530	R 49,530
C021	G	Egra	G.4	3.41	7.5	R 85,075	R 107,872	R 107,872	R 157,293	R 97,302	R 99,340
C022	P	Ppat	P.2	8.41	28.7	R 554,886	R 683,097	R 683,097	R 625,703	R 319,487	R 319,487
C023	G	Egra	G.4	2.74	21.6	R 245,017	R 310,672	R 310,672	R 453,005	R 280,228	R 286,099
C024	G	Edun	G.4	2.56	13	R 147,464	R 186,978	R 186,978	R 272,642	R 168,656	R 172,189
C025	G	Edun	G.4	2.50	0.7	R 5,294	R 8,134	R 8,134	R 13,644	R 6,956	R 7,459
C026	G	Edun	G.4	2.38	1.2	R 9,075	R 13,943	R 13,943	R 23,389	R 11,924	R 12,786
C027	P	Ppat	P.2	9.41	0.8	R 17,401	R 20,504	R 20,504	R 18,767	R 11,007	R 11,007
C028	P	Ppat	P.3	8.33	18.1	R 306,202	R 396,018	R 396,018	R 345,281	R 152,798	R 152,798
C029	P	Ppat	P.3	9.41	16.1	R 306,414	R 376,648	R 376,648	R 330,470	R 174,908	R 174,908
C030	G	Egra	G.5	2.74	8.1	R 80,396	R 109,434	R 109,434	R 148,642	R 82,160	R 84,361
C031	G	Egra	G.5	3.00	7.2	R 71,463	R 97,275	R 97,275	R 132,126	R 73,031	R 74,987
C032	G	Egra	G.5	2.75	10.1	R 100,247	R 136,455	R 136,455	R 185,344	R 102,446	R 105,191
C033	G	Egra	G.5	3.00	2.1	R 20,843	R 28,372	R 28,372	R 38,537	R 21,301	R 21,871
C034	G	Egra	G.5	2.74	16.5	R 163,770	R 222,921	R 222,921	R 302,790	R 167,362	R 171,846
C035	P	Ppat	P.3	8.25	4.4	R 74,436	R 96,269	R 96,269	R 83,936	R 37,144	R 37,144
C036	P	Ppat	P.3	8.25	22.1	R 373,871	R 483,535	R 483,535	R 421,586	R 186,565	R 186,565
C037	G	Egra	G.5	2.64	3	R 29,776	R 40,531	R 40,531	R 55,053	R 30,429	R 31,245
C038	G	Egra	G.4	2.74	11.1	R 125,911	R 159,651	R 159,651	R 232,794	R 144,006	R 147,023
C039	G	Egra	G.4	3.00	1.9	R 21,552	R 27,328	R 27,328	R 39,848	R 24,650	R 25,166
C040	P	Ppat	P.3	9.33	4.7	R 89,450	R 109,953	R 109,953	R 96,473	R 51,060	R 51,060

continued...

Compartment attribute data						Valuation model values per compartment (R)					
Compt	Genus	Species Group	Yield Class	Age	Area	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
C041	G	Edun	G.4	2.64	5.3	R 60,120	R 76,230	R 76,230	R 111,154	R 68,760	R 70,200
C042	G	Edun	G.4	2.66	0.8	R 9,075	R 11,506	R 11,506	R 16,778	R 10,379	R 10,596
C043	P	Ppat	P.3	7.75	2.4	R 40,601	R 52,511	R 52,511	R 45,783	R 20,260	R 20,260
C044	G	Egra	G.1	6.91	18.9	R 750,363	R 696,615	R 750,363	R 796,987	R 766,238	R 773,123
C045	G	Egra	G.5	4.96	1.4	R 23,159	R 26,010	R 26,010	R 29,745	R 21,616	R 22,056
C046	G	Egra	G.5	9.83	4.2	R 138,956	R 138,956	R 138,956	R 138,956	R 138,956	R 138,956
C047	G	Eoth	G.5	9.83	2.9	R 95,946	R 95,946	R 95,946	R 95,946	R 95,946	R 95,946
C048	G	Eoth	G.5	9.66	0.8	R 26,468	R 26,468	R 26,468	R 26,468	R 26,468	R 26,468
C049	G	Egra	G.5	9.41	2.7	R 80,396	R 81,222	R 81,222	R 80,396	R 78,552	R 78,552
C050	G	Egra	G.4	4.13	4.1	R 62,010	R 70,792	R 70,792	R 92,522	R 64,534	R 65,733
C051	G	Egra	G.3	6.75	0.7	R 20,843	R 20,532	R 20,843	R 22,139	R 20,412	R 20,667
C052	P	Ppat	P.2	8.16	1.7	R 32,868	R 40,462	R 40,462	R 37,063	R 18,924	R 18,924
C053	G	Edun	G.3	1.94	8.3	R 70,612	R 100,494	R 100,494	R 181,998	R 104,310	R 110,270
C054	P	Poth	P.2	12.58	3.6	R 113,104	R 118,904	R 118,904	R 113,201	R 95,104	R 95,104
C055	P	Poth	P.2	13.25	21.7	R 681,765	R 716,727	R 716,727	R 682,350	R 573,268	R 573,268
C056	P	Poth	P.2	13.25	6.3	R 197,932	R 208,082	R 208,082	R 198,102	R 166,433	R 166,433
C057	P	Poth	P.2	14.33	4	R 135,338	R 139,600	R 139,600	R 135,338	R 120,824	R 120,824
C058	G	Egra	G.3	8.08	24.2	R 823,528	R 816,858	R 823,528	R 823,528	R 802,384	R 811,869
C059	G	Edun	G.2	2.95	15	R 223,322	R 244,758	R 244,758	R 412,895	R 300,742	R 304,819
C060	G	Edun	G.2	2.95	2.9	R 43,176	R 47,320	R 47,320	R 79,826	R 58,144	R 58,932
C061	P	Ppat	P.2	9.41	1.9	R 41,326	R 48,697	R 48,697	R 44,571	R 26,141	R 26,141
C062	P	Ppat	P.2	9.41	6.3	R 137,030	R 161,468	R 161,468	R 147,788	R 86,678	R 86,678
C063	W	Wattle	W.1	9.91	7.5	R 411,178	R 403,363	R 411,178	R 411,178	R 407,709	R 407,709
C064	W	Wattle	W.1	9.91	2.6	R 142,542	R 139,833	R 142,542	R 142,542	R 141,339	R 141,339
C065	G	Egra	G.3	4.13	14.7	R 250,121	R 271,226	R 271,226	R 373,191	R 276,146	R 280,445
C066	P	Ppat	P.2	8.50	12.4	R 239,742	R 295,136	R 295,136	R 270,338	R 138,036	R 138,036
C067	G	Egra	G.4	5.69	4.8	R 108,896	R 112,381	R 112,381	R 125,409	R 105,214	R 106,839
C068	G	Edun	G.3	4.05	1.4	R 23,821	R 25,831	R 25,831	R 35,542	R 26,300	R 26,709
C069	P	Poth	P.2	14.16	10.6	R 358,646	R 369,940	R 369,940	R 358,646	R 320,184	R 320,184
C070	P	Ppat	P.3	8.41	3.6	R 60,902	R 78,766	R 78,766	R 68,675	R 30,391	R 30,391
C071	P	Ppat	P.3	8.50	6.9	R 116,729	R 150,968	R 150,968	R 131,626	R 58,249	R 58,249
C072	G	Edun	G.3	3.05	13.4	R 171,001	R 203,607	R 203,607	R 316,160	R 211,773	R 215,414
C073	G	Edun	G.3	3.05	23.1	R 294,786	R 350,994	R 350,994	R 545,021	R 365,071	R 371,348
C074	G	Eoth	G.3	7.83	16.6	R 564,899	R 560,324	R 564,899	R 564,899	R 550,395	R 556,902
C075	G	Eoth	G.3	8.75	7.5	R 287,129	R 285,216	R 287,129	R 287,129	R 284,088	R 284,088
C076	W	Wattle	W.4	8.58	8.6	R 249,364	R 258,488	R 258,488	R 249,364	R 235,280	R 235,280
C077	G	Egra	G.5	7.83	21.9	R 579,646	R 594,994	R 594,994	R 579,646	R 547,319	R 555,903
C078	G	Edun	G.4	3.05	8.1	R 91,881	R 116,502	R 116,502	R 169,877	R 105,086	R 107,287
C079	P	Ppat	P.3	8.58	5	R 95,160	R 116,972	R 116,972	R 102,631	R 54,319	R 54,319
C080	G	Edun	G.2	2.64	6.4	R 95,284	R 104,430	R 104,430	R 176,169	R 128,317	R 130,056

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Compartment attribute data						Valuation model values per compartment (R)					
Compt	Genus	Species Group	Yield Class	Age	Area	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
C081	G	Egra	G.3	9.16	2.1	R 80,396	R 79,860	R 80,396	R 80,396	R 79,545	R 79,545
C082	G	Egra	G.4	6.75	4.6	R 121,752	R 122,760	R 122,760	R 129,317	R 116,683	R 118,358
C083	G	Edun	G.3	1.58	1.3	R 11,060	R 15,740	R 15,740	R 28,506	R 16,338	R 17,271
C084	G	Egra	G.4	6.08	15.1	R 342,569	R 353,532	R 353,532	R 394,514	R 330,985	R 336,097
C085	G	Egra	G.4	6.12	7.4	R 167,882	R 173,254	R 173,254	R 193,338	R 162,204	R 164,710
C086	G	Egra	G.4	2.97	7	R 79,404	R 100,681	R 100,681	R 146,807	R 90,815	R 92,717
C087	G	Edun	G.3	3.46	22.1	R 282,024	R 335,799	R 335,799	R 521,427	R 349,267	R 355,273
C088	P	Ppat	P.1	8.91	17.9	R 428,272	R 489,464	R 489,464	R 461,896	R 287,725	R 287,725
C089	G	Egra	G.4	2.95	7	R 79,404	R 100,681	R 100,681	R 146,807	R 90,815	R 92,717
C090	G	Edun	G.3	3.46	6.4	R 81,672	R 97,245	R 97,245	R 151,002	R 101,145	R 102,884
C091	P	Poth	P.1	13.25	1.6	R 55,295	R 57,415	R 57,415	R 55,343	R 47,235	R 47,235
C092	P	Poth	P.1	13.58	11.9	R 442,894	R 453,123	R 453,123	R 442,894	R 399,196	R 399,196
C093	G	Eoth	G.3	9.41	1.2	R 45,941	R 45,635	R 45,941	R 45,941	R 45,454	R 45,454
C094	G	Egra	G.4	5.89	12.1	R 274,509	R 283,293	R 283,293	R 316,134	R 265,226	R 269,323
C095	W	Wattle	W.2	10.08	14	R 624,449	R 621,107	R 624,449	R 624,449	R 614,783	R 614,783
C096	W	Wattle	W.1	10.08	10.5	R 575,649	R 564,708	R 575,649	R 575,649	R 570,792	R 570,792
C097	G	Edun	G.3	3.46	12.7	R 162,068	R 192,971	R 192,971	R 299,644	R 200,710	R 204,161
C098	G	Edun	G.3	2.95	2.2	R 28,075	R 33,428	R 33,428	R 51,907	R 34,769	R 35,367
C099	G	Egra	G.4	5.69	1.5	R 34,030	R 35,119	R 35,119	R 39,190	R 32,879	R 33,387
C100	G	Egra	G.4	5.89	3.3	R 74,866	R 77,262	R 77,262	R 86,218	R 72,334	R 73,452
C101	G	Edun	G.3	3.46	8.7	R 111,023	R 132,192	R 132,192	R 205,268	R 137,494	R 139,858
C102	G	Edun	G.3	3.46	2	R 25,523	R 30,389	R 30,389	R 47,188	R 31,608	R 32,151
C103	G	Edun	G.4	3.46	1.8	R 20,418	R 25,889	R 25,889	R 37,750	R 23,352	R 23,842
C104	G	Egra	G.4	3.58	5.3	R 80,160	R 91,511	R 91,511	R 119,602	R 83,422	R 84,972
C105	W	Wattle	W.2	10.16	5.1	R 227,478	R 226,260	R 227,478	R 227,478	R 223,957	R 223,957
C106	W	Wattle	W.2	7.00	9.5	R 296,613	R 300,267	R 300,267	R 329,390	R 290,153	R 290,153
C107	W	Wattle	W.2	7.00	11	R 343,447	R 347,677	R 347,677	R 381,399	R 335,967	R 335,967
C108	G	Edun	G.3	0.88	8.5	R 0	R 74,290	R 74,290	R 173,219	R 73,342	R 90,886
C109	G	Eoth	G.3	1.94	25.7	R 218,643	R 311,167	R 311,167	R 563,537	R 322,983	R 341,439
C110	G	Egra	G.3	7.33	8.8	R 262,032	R 258,111	R 262,032	R 278,313	R 256,606	R 259,812
C111	G	Egra	G.5	6.66	4.9	R 113,481	R 117,410	R 117,410	R 120,532	R 105,702	R 107,487
C112	G	Egra	G.5	3.46	2.6	R 25,806	R 35,127	R 35,127	R 47,712	R 26,372	R 27,079
C113	G	Egra	G.5	3.58	3.3	R 43,672	R 52,821	R 52,821	R 65,160	R 41,892	R 42,857
C114	G	Eoth	G.5	7.33	3.6	R 83,374	R 86,260	R 86,260	R 88,554	R 77,659	R 78,970
C115	G	Egra	G.4	5.52	1.7	R 38,567	R 39,802	R 39,802	R 44,416	R 37,263	R 37,839
C116	G	Egra	G.5	4.13	12.4	R 164,101	R 198,478	R 198,478	R 244,845	R 157,411	R 161,037
C117	G	Egra	G.5	4.13	3.7	R 48,966	R 59,223	R 59,223	R 73,059	R 46,970	R 48,051
C118	G	Egra	G.5	3.56	4.6	R 60,876	R 73,629	R 73,629	R 90,830	R 58,395	R 59,740
C119	W	Wattle	W.3	10.50	44.6	R 1,796,131	R 1,798,450	R 1,798,450	R 1,796,131	R 1,761,027	R 1,761,027
C120	W	Wattle	W.3	10.16	19.6	R 789,331	R 790,350	R 790,350	R 789,331	R 773,904	R 773,904

continued...

Compartment attribute data						Valuation model values per compartment (R)					
Compt	Genus	Species Group	Yield Class	Age	Area	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
C121	G	Egra	G.4	3.91	17.6	R 266,191	R 303,886	R 303,886	R 397,168	R 277,023	R 282,170
C122	W	Wattle	W.4	8.58	20	R 579,917	R 601,134	R 601,134	R 579,917	R 547,164	R 547,164
C123	G	Eoth	G.4	7.83	13.9	R 420,461	R 423,877	R 423,877	R 420,461	R 404,129	R 409,578
C124	W	Wattle	W.4	8.58	25.1	R 727,796	R 754,423	R 754,423	R 727,796	R 686,690	R 686,690
C125	W	Wattle	W.4	8.75	11.9	R 345,050	R 357,675	R 357,675	R 345,050	R 325,562	R 325,562
C126	W	Wattle	W.4	8.91	16.7	R 484,231	R 501,947	R 501,947	R 484,231	R 456,882	R 456,882
C127	G	Egra	G.6	4.13	42.6	R 483,227	R 624,380	R 624,380	R 720,995	R 411,047	R 423,504
C128	G	Egra	G.5	3.88	11.4	R 150,867	R 182,471	R 182,471	R 225,099	R 144,717	R 148,050
C129	G	Egra	G.5	4.83	15.5	R 256,407	R 287,966	R 287,966	R 329,316	R 239,315	R 244,192
C130	G	Edun	G.4	3.46	6.5	R 73,732	R 93,489	R 93,489	R 136,321	R 84,328	R 86,094
C131	G	Eoth	G.4	4.25	10.2	R 154,270	R 176,116	R 176,116	R 230,177	R 160,548	R 163,530
C132	G	Egra	G.7	4.75	16.6	R 196,146	R 246,844	R 246,844	R 251,919	R 147,504	R 152,727
C133	G	Egxn	G.4	3.91	3.6	R 54,448	R 62,159	R 62,159	R 81,239	R 56,664	R 57,717
C134	G	Egra	G.7	3.91	4	R 37,811	R 52,797	R 52,797	R 56,416	R 26,414	R 27,584
C135	G	Egra	G.5	4.08	16.9	R 223,653	R 270,506	R 270,506	R 333,700	R 214,537	R 219,478
C136	P	Ppat	P.5	15.41	2.9	R 57,821	R 60,061	R 60,061	R 57,821	R 52,521	R 52,521
C137	G	Egra	G.7	4.13	27.3	R 258,061	R 360,339	R 360,339	R 385,038	R 180,275	R 188,258
C138	G	Egra	G.3	7.25	12.2	R 363,271	R 357,836	R 363,271	R 385,843	R 355,749	R 360,194
C139	G	Egra	G.3	6.75	7.7	R 229,278	R 225,847	R 229,278	R 243,524	R 224,530	R 227,335
C140	G	Egra	G.5	0.88	6.3	R 0	R 52,207	R 52,207	R 99,856	R 23,556	R 36,560
C141	G	Eoth	G.3	4.63	0.2	R 4,254	R 4,377	R 4,377	R 5,463	R 4,399	R 4,462
C142	G	Egra	G.5	3.00	1.1	R 10,918	R 14,861	R 14,861	R 20,186	R 11,157	R 11,456
C143	G	Egxn	G.4	3.00	2.2	R 24,955	R 31,643	R 31,643	R 46,139	R 28,542	R 29,140
C144	G	Eoth	G.4	3.00	0.5	R 5,672	R 7,191	R 7,191	R 10,486	R 6,487	R 6,623
C145	G	Eoth	G.4	3.00	0.8	R 9,075	R 11,506	R 11,506	R 16,778	R 10,379	R 10,596
C146	G	Egxu	G.4	3.00	0.8	R 9,075	R 11,506	R 11,506	R 16,778	R 10,379	R 10,596
C147	G	Egra	G.5	3.00	1.6	R 15,881	R 21,617	R 21,617	R 29,361	R 16,229	R 16,664
C148	G	Eoth	G.4	3.00	0.7	R 7,940	R 10,068	R 10,068	R 14,681	R 9,081	R 9,272

APPENDIX 2: VALUE PER HECTARE, AGE CLASS AND YIELD CLASS

2.1 Yield tables per age class and yield class (SV model)

Table 2: Standing Value per age class and yield class for eucalypt

SV	Yield Class							Grand
Age	G.1	G.2	G.3	G.4	G.5	G.6	G.7	Total
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
1	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
2	R 11,343	R 9,925	R 8,508	R 7,562	R 6,617	R 5,672	R 4,726	R 54,354
3	R 17,015	R 14,888	R 12,761	R 11,343	R 9,925	R 8,508	R 7,090	R 81,530
4	R 22,687	R 19,851	R 17,015	R 15,124	R 13,234	R 11,343	R 9,453	R 108,707
5	R 28,358	R 24,814	R 21,269	R 18,906	R 16,542	R 14,179	R 11,816	R 135,884
6	R 34,030	R 29,776	R 25,523	R 22,687	R 19,851	R 17,015	R 14,179	R 163,061
7	R 39,702	R 34,739	R 29,776	R 26,468	R 23,159	R 19,851	R 16,542	R 190,238
8	R 45,373	R 39,702	R 34,030	R 30,249	R 26,468	R 22,687	R 18,906	R 217,414
9	R 51,045	R 44,664	R 38,284	R 34,030	R 29,776	R 25,523	R 21,269	R 244,591
10	R 56,717	R 49,627	R 42,538	R 37,811	R 33,085	R 28,358	R 23,632	R 271,768
Grand Total	R 306,271	R 267,987	R 229,703	R 204,180	R 178,658	R 153,135	R 127,613	R 1,467,547

Table 3: Standing Value per age class and yield class for pine

SV	Yield Class					Grand
Age	P.1	P.2	P.3	P.4	P.5	Total
0	R 0	R 0	R 0	R 0	R 0	R 0
1	R 0	R 0	R 0	R 0	R 0	R 0
2	R 0	R 0	R 0	R 0	R 0	R 0
3	R 7,975	R 7,250	R 0	R 0	R 0	R 15,226
4	R 10,634	R 9,667	R 8,459	R 6,525	R 5,317	R 40,601
5	R 13,292	R 12,084	R 10,573	R 8,157	R 6,646	R 50,752
6	R 15,951	R 14,501	R 12,688	R 9,788	R 7,975	R 60,902
7	R 18,609	R 16,917	R 14,803	R 11,419	R 9,304	R 71,052
8	R 21,267	R 19,334	R 16,917	R 13,050	R 10,634	R 81,203
9	R 23,926	R 21,751	R 19,032	R 14,682	R 11,963	R 91,353
10	R 26,584	R 24,168	R 21,147	R 16,313	R 13,292	R 101,504
11	R 29,243	R 26,584	R 23,261	R 17,944	R 14,621	R 111,654
12	R 31,901	R 29,001	R 25,376	R 19,576	R 15,951	R 121,804
13	R 34,560	R 31,418	R 27,491	R 21,207	R 17,280	R 131,955
14	R 37,218	R 33,835	R 29,605	R 22,838	R 18,609	R 142,105
15	R 39,876	R 36,251	R 31,720	R 24,470	R 19,938	R 152,255
16	R 42,535	R 38,668	R 33,835	R 26,101	R 21,267	R 162,406
Grand Total	R 353,571	R 321,428	R 274,905	R 212,070	R 172,798	R 1,334,771

Table 4: Standing Value per age class and yield class for wattle

SV	Yield Class				Grand Total
Age	W.1	W.2	W.3	W.4	
0	R 0	R 0	R 0	R 0	R 0
1	R 0	R 0	R 0	R 0	R 0
2	R 0	R 0	R 0	R 0	R 0
3	R 16,447	R 13,381	R 12,082	R 9,665	R 51,575
4	R 21,929	R 17,841	R 16,109	R 12,887	R 68,767
5	R 27,412	R 22,302	R 20,136	R 16,109	R 85,958
6	R 32,894	R 26,762	R 24,163	R 19,331	R 103,150
7	R 38,377	R 31,222	R 28,190	R 22,552	R 120,342
8	R 43,859	R 35,683	R 32,218	R 25,774	R 137,533
9	R 49,341	R 40,143	R 36,245	R 28,996	R 154,725
10	R 54,824	R 44,604	R 40,272	R 32,218	R 171,917
11	R 60,306	R 49,064	R 44,299	R 35,439	R 189,109
Grand Total	R 345,389	R 281,002	R 253,714	R 202,971	R 1,083,076

2.2 Yield tables per age class and yield class (CV model)

Table 5: Cost Value per age class and yield class for eucalypt

CV	Yield Class							Grand Total
Age	G.1	G.2	G.3	G.4	G.5	G.6	G.7	
0	R 4,665	R 4,665	R 4,665	R 4,665	R 4,665	R 4,665	R 4,665	R 32,654
1	R 9,292	R 9,032	R 8,740	R 8,524	R 8,287	R 8,023	R 7,727	R 59,626
2	R 13,379	R 12,775	R 12,108	R 11,619	R 11,089	R 10,506	R 9,860	R 81,337
3	R 17,346	R 16,317	R 15,195	R 14,383	R 13,510	R 12,565	R 11,529	R 100,845
4	R 21,648	R 20,109	R 18,451	R 17,266	R 16,006	R 14,657	R 13,199	R 121,336
5	R 26,313	R 24,168	R 21,886	R 20,274	R 18,578	R 16,783	R 14,870	R 142,872
6	R 31,372	R 28,512	R 25,509	R 23,413	R 21,229	R 18,945	R 16,542	R 165,522
7	R 36,858	R 33,164	R 29,331	R 26,687	R 23,961	R 21,142	R 18,215	R 189,358
8	R 43,199	R 38,535	R 33,754	R 30,495	R 27,169	R 23,768	R 20,281	R 217,200
9	R 49,684	R 43,892	R 38,029	R 34,075	R 30,082	R 26,044	R 21,956	R 243,763
10	R 56,717	R 49,627	R 42,538	R 37,811	R 33,085	R 28,358	R 23,632	R 271,768
Grand Total	R 310,474	R 280,795	R 250,204	R 229,213	R 207,661	R 185,457	R 162,477	R 1,626,280

Table 6: Cost Value per age class and yield class for pine

CV	Yield Class					Grand
Age	P.1	P.2	P.3	P.4	P.5	Total
0	R 5,412	R 5,412	R 5,412	R 5,412	R 5,412	R 27,060
1	R 9,035	R 8,914	R 8,749	R 8,441	R 8,211	R 43,351
2	R 12,110	R 11,847	R 11,488	R 10,825	R 10,335	R 56,605
3	R 14,633	R 14,207	R 13,629	R 12,575	R 11,807	R 66,850
4	R 16,596	R 15,991	R 15,176	R 13,704	R 12,645	R 74,113
5	R 19,163	R 18,366	R 17,299	R 15,393	R 14,039	R 84,259
6	R 21,175	R 20,169	R 18,832	R 16,466	R 14,806	R 91,449
7	R 23,210	R 21,981	R 20,359	R 17,518	R 15,550	R 98,618
8	R 25,266	R 23,801	R 21,879	R 18,550	R 16,270	R 105,766
9	R 27,344	R 25,630	R 23,394	R 19,561	R 16,967	R 112,897
10	R 29,445	R 27,467	R 24,903	R 20,552	R 17,642	R 120,010
11	R 31,569	R 29,312	R 26,406	R 21,524	R 18,296	R 127,107
12	R 33,715	R 31,166	R 27,904	R 22,476	R 18,929	R 134,190
13	R 35,885	R 33,029	R 29,395	R 23,410	R 19,542	R 141,260
14	R 38,078	R 34,900	R 30,881	R 24,325	R 20,136	R 148,319
15	R 40,294	R 36,780	R 32,360	R 25,222	R 20,711	R 155,367
16	R 42,535	R 38,668	R 33,835	R 26,101	R 21,267	R 162,406
Grand Total	R 425,464	R 397,640	R 361,902	R 302,054	R 262,564	R 1,749,625

Table 7: Cost Value per age class and yield class for wattle

CV	Yield Class				Grand
Age	W.1	W.2	W.3	W.4	Total
0	R 5,032	R 5,032	R 5,032	R 5,032	R 20,128
1	R 9,732	R 9,356	R 9,176	R 8,795	R 37,060
2	R 14,216	R 13,352	R 12,942	R 12,090	R 52,600
3	R 18,236	R 16,769	R 16,083	R 14,674	R 65,762
4	R 22,816	R 20,638	R 19,631	R 17,589	R 80,673
5	R 27,130	R 24,112	R 22,734	R 19,974	R 93,950
6	R 31,752	R 27,765	R 25,967	R 22,413	R 107,897
7	R 36,703	R 31,607	R 29,337	R 24,905	R 122,553
8	R 42,008	R 35,647	R 32,849	R 27,453	R 137,958
9	R 47,692	R 39,896	R 36,510	R 30,057	R 154,155
10	R 53,782	R 44,365	R 40,324	R 32,719	R 171,189
11	R 60,306	R 49,064	R 44,299	R 35,439	R 189,108
Grand Total	R 369,406	R 317,603	R 294,884	R 251,138	R 1,233,031

2.3 Yield tables per age class and yield class (MAX(CV,SV) model)

Table 8: MAX(CV,SV) value per age class and yield class for eucalypt

MAX(CV,SV)	Yield Class							Grand
Age	**G.1**	**G.2**	**G.3**	**G.4**	**G.5**	**G.6**	**G.7**	**Total**
0	R 4,665	R 4,665	R 4,665	R 4,665	R 4,665	R 4,665	R 4,665	R 32,654
1	R 9,292	R 9,032	R 8,740	R 8,524	R 8,287	R 8,023	R 7,727	R 59,626
2	R 13,379	R 12,775	R 12,108	R 11,619	R 11,089	R 10,506	R 9,860	R 81,337
3	R 17,346	R 16,317	R 15,195	R 14,383	R 13,510	R 12,565	R 11,529	R 100,845
4	R 22,687	R 20,109	R 18,451	R 17,266	R 16,006	R 14,657	R 13,199	R 122,375
5	R 28,358	R 24,814	R 21,886	R 20,274	R 18,578	R 16,783	R 14,870	R 145,564
6	R 34,030	R 29,776	R 25,523	R 23,413	R 21,229	R 18,945	R 16,542	R 169,458
7	R 39,702	R 34,739	R 29,776	R 26,687	R 23,961	R 21,142	R 18,215	R 194,222
8	R 45,373	R 39,702	R 34,030	R 30,495	R 27,169	R 23,768	R 20,281	R 220,817
9	R 51,045	R 44,664	R 38,284	R 34,075	R 30,082	R 26,044	R 21,956	R 246,151
10	R 56,717	R 49,627	R 42,538	R 37,811	R 33,085	R 28,358	R 23,632	R 271,768
Grand Total	R 322,595	R 286,220	R 251,194	R 229,213	R 207,661	R 185,457	R 162,477	R 1,644,817

Table 9: MAX(CV,SV) value per age class and yield class for pine

MAX(CV,SV)	**Yield Class**					**Grand Total**
Age	**P.1**	**P.2**	**P.3**	**P.4**	**P.5**	
0	R 5,412	R 5,412	R 5,412	R 5,412	R 5,412	R 27,060
1	R 9,035	R 8,914	R 8,749	R 8,441	R 8,211	R 43,351
2	R 12,110	R 11,847	R 11,488	R 10,825	R 10,335	R 56,605
3	R 14,633	R 14,207	R 13,629	R 12,575	R 11,807	R 66,850
4	R 16,596	R 15,991	R 15,176	R 13,704	R 12,645	R 74,113
5	R 19,163	R 18,366	R 17,299	R 15,393	R 14,039	R 84,259
6	R 21,175	R 20,169	R 18,832	R 16,466	R 14,806	R 91,449
7	R 23,210	R 21,981	R 20,359	R 17,518	R 15,550	R 98,618
8	R 25,266	R 23,801	R 21,879	R 18,550	R 16,270	R 105,766
9	R 27,344	R 25,630	R 23,394	R 19,561	R 16,967	R 112,897
10	R 29,445	R 27,467	R 24,903	R 20,552	R 17,642	R 120,010
11	R 31,569	R 29,312	R 26,406	R 21,524	R 18,296	R 127,107
12	R 33,715	R 31,166	R 27,904	R 22,476	R 18,929	R 134,190
13	R 35,885	R 33,029	R 29,395	R 23,410	R 19,542	R 141,260
14	R 38,078	R 34,900	R 30,881	R 24,325	R 20,136	R 148,319
15	R 40,294	R 36,780	R 32,360	R 25,222	R 20,711	R 155,367
16	R 42,535	R 38,668	R 33,835	R 26,101	R 21,267	R 162,406
Grand Total	R 425,464	R 397,640	R 361,902	R 302,054	R 262,564	R 1,749,625

Table 10: MAX(CV,SV) value per age class and yield class for wattle

MAX(CV,SV)	Yield Class				Grand Total
Age	W.1	W.2	W.3	W.4	
0	R 5,032	R 5,032	R 5,032	R 5,032	R 20,128
1	R 9,732	R 9,356	R 9,176	R 8,795	R 37,060
2	R 14,216	R 13,352	R 12,942	R 12,090	R 52,600
3	R 18,236	R 16,769	R 16,083	R 14,674	R 65,762
4	R 22,816	R 20,638	R 19,631	R 17,589	R 80,673
5	R 27,412	R 24,112	R 22,734	R 19,974	R 94,231
6	R 32,894	R 27,765	R 25,967	R 22,413	R 109,039
7	R 38,377	R 31,607	R 29,337	R 24,905	R 124,226
8	R 43,859	R 35,683	R 32,849	R 27,453	R 139,844
9	R 49,341	R 40,143	R 36,510	R 30,057	R 156,051
10	R 54,824	R 44,604	R 40,324	R 32,719	R 172,470
11	R 60,306	R 49,064	R 44,299	R 35,439	R 189,109
Grand Total	R 377,045	R 318,124	R 294,884	R 251,138	R 1,241,192

2.4 Yield tables per age class and yield class (DCF1 model)

Table 11: DCF1 value per age class and yield class for eucalypt

DCF1	Yield Class							Grand
Age	G.1	G.2	G.3	G.4	G.5	G.6	G.7	Total
0	R 25,252	R 22,096	R 18,939	R 16,835	R 14,731	R 12,626	R 10,522	R 121,001
1	R 27,172	R 23,775	R 20,379	R 18,114	R 15,850	R 13,586	R 11,322	R 130,197
2	R 29,237	R 25,582	R 21,928	R 19,491	R 17,055	R 14,618	R 12,182	R 140,092
3	R 31,459	R 27,526	R 23,594	R 20,972	R 18,351	R 15,729	R 13,108	R 150,739
4	R 33,850	R 29,618	R 25,387	R 22,566	R 19,746	R 16,925	R 14,104	R 162,196
5	R 36,422	R 31,869	R 27,317	R 24,281	R 21,246	R 18,211	R 15,176	R 174,523
6	R 39,190	R 34,291	R 29,393	R 26,127	R 22,861	R 19,595	R 16,329	R 187,786
7	R 42,169	R 36,898	R 31,626	R 28,112	R 24,598	R 21,084	R 17,570	R 202,058
8	R 45,373	R 39,702	R 34,030	R 30,249	R 26,468	R 22,687	R 18,906	R 217,414
9	R 51,045	R 44,664	R 38,284	R 34,030	R 29,776	R 25,523	R 21,269	R 244,591
10	R 56,717	R 49,627	R 42,538	R 37,811	R 33,085	R 28,358	R 23,632	R 271,768
Grand Total	R 417,885	R 365,650	R 313,414	R 278,590	R 243,766	R 208,943	R 174,119	R 2,002,367

Table 12: DCF1 value per age class and yield class for pine

DCF1	Yield Class					Grand Total
Age	P.1	P.2	P.3	P.4	P.5	
0	R 13,347	R 12,134	R 10,617	R 8,190	R 6,673	R 50,961
1	R 14,361	R 13,056	R 11,424	R 8,813	R 7,181	R 54,834
2	R 15,453	R 14,048	R 12,292	R 9,482	R 7,726	R 59,001
3	R 16,627	R 15,116	R 13,226	R 10,203	R 8,314	R 63,485
4	R 17,891	R 16,264	R 14,231	R 10,978	R 8,945	R 68,310
5	R 19,250	R 17,500	R 15,313	R 11,813	R 9,625	R 73,502
6	R 20,714	R 18,830	R 16,477	R 12,711	R 10,357	R 79,088
7	R 22,288	R 20,262	R 17,729	R 13,677	R 11,144	R 85,099
8	R 23,982	R 21,801	R 19,076	R 14,716	R 11,991	R 91,566
9	R 25,804	R 23,458	R 20,526	R 15,834	R 12,902	R 98,525
10	R 27,765	R 25,241	R 22,086	R 17,038	R 13,883	R 106,013
11	R 29,876	R 27,160	R 23,765	R 18,333	R 14,938	R 114,070
12	R 32,146	R 29,224	R 25,571	R 19,726	R 16,073	R 122,740
13	R 34,589	R 31,445	R 27,514	R 21,225	R 17,295	R 132,068
14	R 37,218	R 33,835	R 29,605	R 22,838	R 18,609	R 142,105
15	R 39,876	R 36,251	R 31,720	R 24,470	R 19,938	R 152,255
16	R 42,535	R 38,668	R 33,835	R 26,101	R 21,267	R 162,406
Grand Total	R 433,722	R 394,293	R 345,006	R 266,147	R 216,861	R 1,656,029

Table 13: DCF1 value per age class and yield class for wattle

DCF1	Yield Class				Grand
Age	W.1	W.2	W.3	W.4	Total
0	R 25,521	R 20,764	R 18,747	R 14,998	R 80,030
1	R 27,461	R 22,342	R 20,172	R 16,138	R 86,112
2	R 29,548	R 24,040	R 21,705	R 17,364	R 92,656
3	R 31,793	R 25,867	R 23,355	R 18,684	R 99,698
4	R 34,210	R 27,832	R 25,130	R 20,104	R 107,275
5	R 36,810	R 29,948	R 27,039	R 21,631	R 115,428
6	R 39,607	R 32,224	R 29,094	R 23,275	R 124,201
7	R 42,617	R 34,673	R 31,306	R 25,044	R 133,640
8	R 45,856	R 37,308	R 33,685	R 26,948	R 143,797
9	R 49,341	R 40,143	R 36,245	R 28,996	R 154,725
10	R 54,824	R 44,604	R 40,272	R 32,218	R 171,917
11	R 60,306	R 49,064	R 44,299	R 35,439	R 189,109
Grand Total	R 477,894	R 388,806	R 351,048	R 280,839	R 1,498,587

2.5 Yield tables per age class and yield class (DCF2 model)

Table 14: DCF2 value per age class and yield class for eucalypt

DCF2	Yield Class							Grand
Age	G.1	G.2	G.3	G.4	G.5	G.6	G.7	Total
0	R 8,516	R 5,108	R 1,700	-R 572	-R 2,844	-R 5,116	-R 7,388	-R 599
1	R 15,962	R 12,295	R 8,628	R 6,184	R 3,739	R 1,294	-R 1,150	R 46,954
2	R 20,459	R 16,513	R 12,567	R 9,937	R 7,307	R 4,676	R 2,046	R 73,505
3	R 24,295	R 20,049	R 15,804	R 12,974	R 10,143	R 7,313	R 4,482	R 95,060
4	R 27,922	R 23,354	R 18,785	R 15,740	R 12,694	R 9,649	R 6,603	R 114,748
5	R 31,824	R 26,909	R 21,994	R 18,717	R 15,440	R 12,163	R 8,886	R 135,932
6	R 36,023	R 30,734	R 25,445	R 21,920	R 18,394	R 14,868	R 11,342	R 158,726
7	R 40,542	R 34,851	R 29,160	R 25,366	R 21,572	R 17,778	R 13,984	R 183,252
8	R 45,403	R 39,280	R 33,156	R 29,074	R 24,992	R 20,909	R 16,827	R 209,642
9	R 51,056	R 44,467	R 37,878	R 33,486	R 29,093	R 24,701	R 20,308	R 240,990
10	R 56,717	R 49,627	R 42,538	R 37,811	R 33,085	R 28,358	R 23,632	R 271,768
Grand Total	R 358,720	R 303,188	R 247,656	R 210,635	R 173,614	R 136,592	R 99,571	R 1,529,976

Table 15: DCF2 value per age class and yield class for pine

DCF2	Yield Class					Grand
Age	P.1	P.2	P.3	P.4	P.5	Total
0	-R 11,928	-R 13,126	-R 14,623	-R 17,018	-R 18,516	-R 75,211
1	-R 5,231	-R 6,520	-R 8,131	-R 10,708	-R 12,319	-R 42,909
2	-R 1,956	-R 3,343	-R 5,076	-R 7,849	-R 9,583	-R 27,807
3	R 937	-R 555	-R 2,420	-R 5,404	-R 7,269	-R 14,711
4	R 3,420	R 1,814	-R 193	-R 3,404	-R 5,411	-R 3,773
5	R 5,460	R 3,732	R 1,573	-R 1,882	-R 4,041	R 4,842
6	R 8,281	R 6,422	R 4,099	R 381	-R 1,942	R 17,242
7	R 10,691	R 8,691	R 6,191	R 2,191	-R 309	R 27,455
8	R 13,284	R 11,132	R 8,442	R 4,138	R 1,448	R 38,443
9	R 16,074	R 13,758	R 10,864	R 6,233	R 3,338	R 50,267
10	R 19,076	R 16,584	R 13,470	R 8,487	R 5,372	R 62,990
11	R 22,306	R 19,625	R 16,274	R 10,912	R 7,561	R 76,679
12	R 25,782	R 22,897	R 19,291	R 13,522	R 9,916	R 91,409
13	R 29,522	R 26,418	R 22,538	R 16,330	R 12,450	R 107,258
14	R 33,546	R 30,206	R 26,031	R 19,352	R 15,177	R 124,311
15	R 37,876	R 34,282	R 29,790	R 22,603	R 18,111	R 142,661
16	R 42,535	R 38,668	R 33,835	R 26,101	R 21,267	R 162,406
Grand Total	R 249,675	R 210,688	R 161,955	R 83,983	R 35,250	R 741,551

Table 16: DCF2 value per age class and yield class for wattle

DCF2	Yield Class				Grand
Age	W.1	W.2	W.3	W.4	Total
0	R 5,516	R 493	-R 1,635	-R 5,594	-R 1,220
1	R 13,163	R 7,758	R 5,468	R 1,209	R 27,598
2	R 17,759	R 11,944	R 9,479	R 4,897	R 44,078
3	R 22,110	R 15,853	R 13,201	R 8,270	R 59,434
4	R 25,948	R 19,215	R 16,362	R 11,057	R 72,582
5	R 30,373	R 23,129	R 20,058	R 14,350	R 87,909
6	R 34,494	R 26,700	R 23,396	R 17,254	R 101,844
7	R 38,929	R 30,542	R 26,988	R 20,378	R 116,838
8	R 43,701	R 34,677	R 30,852	R 23,740	R 132,971
9	R 48,836	R 39,126	R 35,011	R 27,358	R 150,331
10	R 54,361	R 43,913	R 39,485	R 31,251	R 169,010
11	R 60,306	R 49,064	R 44,299	R 35,439	R 189,109
Grand Total	R 395,496	R 302,415	R 262,965	R 189,609	R 1,150,485

2.6 Yield tables per age class and yield class (NDSV model)

Table 17: NDSV value per age class and yield class for eucalypt

NDSV	Yield Class							Grand Total
Age	G.1	G.2	G.3	G.4	G.5	G.6	G.7	
0	R 15,099	R 11,691	R 8,283	R 6,011	R 3,739	R 1,467	-R 805	R 45,482
1	R 18,027	R 14,360	R 10,693	R 8,248	R 5,803	R 3,358	R 914	R 61,402
2	R 21,177	R 17,231	R 13,286	R 10,655	R 8,025	R 5,394	R 2,764	R 78,531
3	R 24,567	R 20,321	R 16,076	R 13,245	R 10,415	R 7,585	R 4,754	R 96,963
4	R 28,214	R 23,646	R 19,078	R 16,032	R 12,987	R 9,941	R 6,896	R 116,795
5	R 32,139	R 27,224	R 22,308	R 19,031	R 15,754	R 12,477	R 9,200	R 138,134
6	R 36,362	R 31,073	R 25,784	R 22,258	R 18,732	R 15,206	R 11,680	R 161,095
7	R 40,906	R 35,215	R 29,524	R 25,730	R 21,936	R 18,142	R 14,348	R 185,802
8	R 45,795	R 39,672	R 33,548	R 29,466	R 25,384	R 21,301	R 17,219	R 212,386
9	R 51,056	R 44,467	R 37,878	R 33,486	R 29,093	R 24,701	R 20,308	R 240,990
10	R 56,717	R 49,627	R 42,538	R 37,811	R 33,085	R 28,358	R 23,632	R 271,768
Grand Total	R 370,058	R 314,527	R 258,995	R 221,974	R 184,953	R 147,931	R 110,910	R 1,609,348

Table 18: NDSV value per age class and yield class for pine

NDSV	Yield Class					Grand
Age	P.1	P.2	P.3	P.4	P.5	Total
0	-R 2,995	-R 4,193	-R 5,690	-R 8,086	-R 9,583	-R 30,548
1	-R 1,443	-R 2,731	-R 4,342	-R 6,920	-R 8,531	-R 23,967
2	R 228	-R 1,159	-R 2,892	-R 5,665	-R 7,399	-R 16,886
3	R 2,026	R 534	-R 1,331	-R 4,315	-R 6,181	-R 9,268
4	R 3,960	R 2,355	R 348	-R 2,863	-R 4,870	-R 1,070
5	R 6,042	R 4,314	R 2,155	-R 1,300	-R 3,460	R 7,751
6	R 8,281	R 6,422	R 4,099	R 381	-R 1,942	R 17,242
7	R 10,691	R 8,691	R 6,191	R 2,191	-R 309	R 27,455
8	R 13,284	R 11,132	R 8,442	R 4,138	R 1,448	R 38,443
9	R 16,074	R 13,758	R 10,864	R 6,233	R 3,338	R 50,267
10	R 19,076	R 16,584	R 13,470	R 8,487	R 5,372	R 62,990
11	R 22,306	R 19,625	R 16,274	R 10,912	R 7,561	R 76,679
12	R 25,782	R 22,897	R 19,291	R 13,522	R 9,916	R 91,409
13	R 29,522	R 26,418	R 22,538	R 16,330	R 12,450	R 107,258
14	R 33,546	R 30,206	R 26,031	R 19,352	R 15,177	R 124,311
15	R 37,876	R 34,282	R 29,790	R 22,603	R 18,111	R 142,661
16	R 42,535	R 38,668	R 33,835	R 26,101	R 21,267	R 162,406
Grand Total	R 266,791	R 227,804	R 179,072	R 101,099	R 52,366	R 827,132

Table 19: NDSV value per age class and yield class for wattle

NDSV	Yield Class				Grand Total
Age	W.1	W.2	W.3	W.4	
0	R 13,741	R 8,718	R 6,590	R 2,631	R 31,680
1	R 16,598	R 11,194	R 8,904	R 4,645	R 41,341
2	R 19,673	R 13,858	R 11,394	R 6,811	R 51,737
3	R 22,982	R 16,725	R 14,073	R 9,142	R 62,923
4	R 26,542	R 19,810	R 16,956	R 11,651	R 74,958
5	R 30,373	R 23,129	R 20,058	R 14,350	R 87,909
6	R 34,494	R 26,700	R 23,396	R 17,254	R 101,844
7	R 38,929	R 30,542	R 26,988	R 20,378	R 116,838
8	R 43,701	R 34,677	R 30,852	R 23,740	R 132,971
9	R 48,836	R 39,126	R 35,011	R 27,358	R 150,331
10	R 54,361	R 43,913	R 39,485	R 31,251	R 169,010
11	R 60,306	R 49,064	R 44,299	R 35,439	R 189,109
Grand Total	R 410,537	R 317,456	R 278,007	R 204,651	R 1,210,650

APPENDIX 3: VALUE PER HECTARE PER MODEL, AGE CLASS AND YIELD CLASS

3.1 Value per model for yield class (eucalypt)

Table 20: Value per model for yield class G.1 (eucalypt)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 4,665	R 4,665	R 25,252	R 8,516	R 15,099
1	R 0	R 9,292	R 9,292	R 27,172	R 15,962	R 18,027
2	R 11,343	R 13,379	R 13,379	R 29,237	R 20,459	R 21,177
3	R 17,015	R 17,346	R 17,346	R 31,459	R 24,295	R 24,567
4	R 22,687	R 21,648	R 22,687	R 33,850	R 27,922	R 28,214
5	R 28,358	R 26,313	R 28,358	R 36,422	R 31,824	R 32,139
6	R 34,030	R 31,372	R 34,030	R 39,190	R 36,023	R 36,362
7	R 39,702	R 36,858	R 39,702	R 42,169	R 40,542	R 40,906
8	R 45,373	R 43,199	R 45,373	R 45,373	R 45,403	R 45,795
9	R 51,045	R 49,684	R 51,045	R 51,045	R 51,056	R 51,056
10	R 56,717	R 56,717	R 56,717	R 56,717	R 56,717	R 56,717
Grand Total	R 306,271	R 310,474	R 322,595	R 417,885	R 358,720	R 370,058

Table 21: Value per model for yield class G.2 (eucalypt)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 4,665	R 4,665	R 22,096	R 5,108	R 11,691
1	R 0	R 9,032	R 9,032	R 23,775	R 12,295	R 14,360
2	R 9,925	R 12,775	R 12,775	R 25,582	R 16,513	R 17,231
3	R 14,888	R 16,317	R 16,317	R 27,526	R 20,049	R 20,321
4	R 19,851	R 20,109	R 20,109	R 29,618	R 23,354	R 23,646
5	R 24,814	R 24,168	R 24,814	R 31,869	R 26,909	R 27,224
6	R 29,776	R 28,512	R 29,776	R 34,291	R 30,734	R 31,073
7	R 34,739	R 33,164	R 34,739	R 36,898	R 34,851	R 35,215
8	R 39,702	R 38,535	R 39,702	R 39,702	R 39,280	R 39,672
9	R 44,664	R 43,892	R 44,664	R 44,664	R 44,467	R 44,467
10	R 49,627	R 49,627	R 49,627	R 49,627	R 49,627	R 49,627
Grand Total	R 267,987	R 280,795	R 286,220	R 365,650	R 303,188	R 314,527

Table 22: Value per model for yield class G.3 (eucalypt)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 4,665	R 4,665	R 18,939	R 1,700	R 8,283
1	R 0	R 8,740	R 8,740	R 20,379	R 8,628	R 10,693
2	R 8,508	R 12,108	R 12,108	R 21,928	R 12,567	R 13,286
3	R 12,761	R 15,195	R 15,195	R 23,594	R 15,804	R 16,076
4	R 17,015	R 18,451	R 18,451	R 25,387	R 18,785	R 19,078
5	R 21,269	R 21,886	R 21,886	R 27,317	R 21,994	R 22,308
6	R 25,523	R 25,509	R 25,523	R 29,393	R 25,445	R 25,784
7	R 29,776	R 29,331	R 29,776	R 31,626	R 29,160	R 29,524
8	R 34,030	R 33,754	R 34,030	R 34,030	R 33,156	R 33,548
9	R 38,284	R 38,029	R 38,284	R 38,284	R 37,878	R 37,878
10	R 42,538	R 42,538	R 42,538	R 42,538	R 42,538	R 42,538
Grand Total	R 229,703	R 250,204	R 251,194	R 313,414	R 247,656	R 258,995

Table 23: Value per model for yield class G.4 (eucalypt)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 4,665	R 4,665	R 16,835	-R 572	R 6,011
1	R 0	R 8,524	R 8,524	R 18,114	R 6,184	R 8,248
2	R 7,562	R 11,619	R 11,619	R 19,491	R 9,937	R 10,655
3	R 11,343	R 14,383	R 14,383	R 20,972	R 12,974	R 13,245
4	R 15,124	R 17,266	R 17,266	R 22,566	R 15,740	R 16,032
5	R 18,906	R 20,274	R 20,274	R 24,281	R 18,717	R 19,031
6	R 22,687	R 23,413	R 23,413	R 26,127	R 21,920	R 22,258
7	R 26,468	R 26,687	R 26,687	R 28,112	R 25,366	R 25,730
8	R 30,249	R 30,495	R 30,495	R 30,249	R 29,074	R 29,466
9	R 34,030	R 34,075	R 34,075	R 34,030	R 33,486	R 33,486
10	R 37,811	R 37,811	R 37,811	R 37,811	R 37,811	R 37,811
Grand Total	R 204,180	R 229,213	R 229,213	R 278,590	R 210,635	R 221,974

Table 24: Value per model for yield class G.5 (eucalypt)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 4,665	R 4,665	R 14,731	-R 2,844	R 3,739
1	R 0	R 8,287	R 8,287	R 15,850	R 3,739	R 5,803
2	R 6,617	R 11,089	R 11,089	R 17,055	R 7,307	R 8,025
3	R 9,925	R 13,510	R 13,510	R 18,351	R 10,143	R 10,415
4	R 13,234	R 16,006	R 16,006	R 19,746	R 12,694	R 12,987
5	R 16,542	R 18,578	R 18,578	R 21,246	R 15,440	R 15,754
6	R 19,851	R 21,229	R 21,229	R 22,861	R 18,394	R 18,732
7	R 23,159	R 23,961	R 23,961	R 24,598	R 21,572	R 21,936
8	R 26,468	R 27,169	R 27,169	R 26,468	R 24,992	R 25,384
9	R 29,776	R 30,082	R 30,082	R 29,776	R 29,093	R 29,093
10	R 33,085	R 33,085	R 33,085	R 33,085	R 33,085	R 33,085
Grand Total	R 178,658	R 207,661	R 207,661	R 243,766	R 173,614	R 184,953

Table 25: Value per model for yield class G.6 (eucalypt)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 4,665	R 4,665	R 12,626	-R 5,116	R 1,467
1	R 0	R 8,023	R 8,023	R 13,586	R 1,294	R 3,358
2	R 5,672	R 10,506	R 10,506	R 14,618	R 4,676	R 5,394
3	R 8,508	R 12,565	R 12,565	R 15,729	R 7,313	R 7,585
4	R 11,343	R 14,657	R 14,657	R 16,925	R 9,649	R 9,941
5	R 14,179	R 16,783	R 16,783	R 18,211	R 12,163	R 12,477
6	R 17,015	R 18,945	R 18,945	R 19,595	R 14,868	R 15,206
7	R 19,851	R 21,142	R 21,142	R 21,084	R 17,778	R 18,142
8	R 22,687	R 23,768	R 23,768	R 22,687	R 20,909	R 21,301
9	R 25,523	R 26,044	R 26,044	R 25,523	R 24,701	R 24,701
10	R 28,358	R 28,358	R 28,358	R 28,358	R 28,358	R 28,358
Grand Total	R 153,135	R 185,457	R 185,457	R 208,943	R 136,592	R 147,931

Table 26: Value per model for yield class G.7 (eucalypt)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 4,665	R 4,665	R 10,522	-R 7,388	-R 805
1	R 0	R 7,727	R 7,727	R 11,322	-R 1,150	R 914
2	R 4,726	R 9,860	R 9,860	R 12,182	R 2,046	R 2,764
3	R 7,090	R 11,529	R 11,529	R 13,108	R 4,482	R 4,754
4	R 9,453	R 13,199	R 13,199	R 14,104	R 6,603	R 6,896
5	R 11,816	R 14,870	R 14,870	R 15,176	R 8,886	R 9,200
6	R 14,179	R 16,542	R 16,542	R 16,329	R 11,342	R 11,680
7	R 16,542	R 18,215	R 18,215	R 17,570	R 13,984	R 14,348
8	R 18,906	R 20,281	R 20,281	R 18,906	R 16,827	R 17,219
9	R 21,269	R 21,956	R 21,956	R 21,269	R 20,308	R 20,308
10	R 23,632	R 23,632	R 23,632	R 23,632	R 23,632	R 23,632
Grand Total	R 127,613	R 162,477	R 162,477	R 174,119	R 99,571	R 110,910

3.2 Value per model for yield class (pine)

Table 27: Value per model for yield class P.1 (pine)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,412	R 5,412	R 13,347	-R 11,928	-R 2,995
1	R 0	R 9,035	R 9,035	R 14,361	-R 5,231	-R 1,443
2	R 0	R 12,110	R 12,110	R 15,453	-R 1,956	R 228
3	R 7,975	R 14,633	R 14,633	R 16,627	R 937	R 2,026
4	R 10,634	R 16,596	R 16,596	R 17,891	R 3,420	R 3,960
5	R 13,292	R 19,163	R 19,163	R 19,250	R 5,460	R 6,042
6	R 15,951	R 21,175	R 21,175	R 20,714	R 8,281	R 8,281
7	R 18,609	R 23,210	R 23,210	R 22,288	R 10,691	R 10,691
8	R 21,267	R 25,266	R 25,266	R 23,982	R 13,284	R 13,284
9	R 23,926	R 27,344	R 27,344	R 25,804	R 16,074	R 16,074
10	R 26,584	R 29,445	R 29,445	R 27,765	R 19,076	R 19,076
11	R 29,243	R 31,569	R 31,569	R 29,876	R 22,306	R 22,306
12	R 31,901	R 33,715	R 33,715	R 32,146	R 25,782	R 25,782
13	R 34,560	R 35,885	R 35,885	R 34,589	R 29,522	R 29,522
14	R 37,218	R 38,078	R 38,078	R 37,218	R 33,546	R 33,546
15	R 39,876	R 40,294	R 40,294	R 39,876	R 37,876	R 37,876
16	R 42,535	R 42,535	R 42,535	R 42,535	R 42,535	R 42,535
Grand Total	R 353,571	R 425,464	R 425,464	R 433,722	R 249,675	R 266,791

Table 28: Value per model for yield class P.2 (pine)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,412	R 5,412	R 12,134	-R 13,126	-R 4,193
1	R 0	R 8,914	R 8,914	R 13,056	-R 6,520	-R 2,731
2	R 0	R 11,847	R 11,847	R 14,048	-R 3,343	-R 1,159
3	R 7,250	R 14,207	R 14,207	R 15,116	-R 555	R 534
4	R 9,667	R 15,991	R 15,991	R 16,264	R 1,814	R 2,355
5	R 12,084	R 18,366	R 18,366	R 17,500	R 3,732	R 4,314
6	R 14,501	R 20,169	R 20,169	R 18,830	R 6,422	R 6,422
7	R 16,917	R 21,981	R 21,981	R 20,262	R 8,691	R 8,691
8	R 19,334	R 23,801	R 23,801	R 21,801	R 11,132	R 11,132
9	R 21,751	R 25,630	R 25,630	R 23,458	R 13,758	R 13,758
10	R 24,168	R 27,467	R 27,467	R 25,241	R 16,584	R 16,584
11	R 26,584	R 29,312	R 29,312	R 27,160	R 19,625	R 19,625
12	R 29,001	R 31,166	R 31,166	R 29,224	R 22,897	R 22,897
13	R 31,418	R 33,029	R 33,029	R 31,445	R 26,418	R 26,418
14	R 33,835	R 34,900	R 34,900	R 33,835	R 30,206	R 30,206
15	R 36,251	R 36,780	R 36,780	R 36,251	R 34,282	R 34,282
16	R 38,668	R 38,668	R 38,668	R 38,668	R 38,668	R 38,668
Grand Total	R 321,428	R 397,640	R 397,640	R 394,293	R 210,688	R 227,804

Table 29: Value per model for yield class P.3 (pine)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,412	R 5,412	R 10,617	-R 14,623	-R 5,690
1	R 0	R 8,749	R 8,749	R 11,424	-R 8,131	-R 4,342
2	R 0	R 11,488	R 11,488	R 12,292	-R 5,076	-R 2,892
3	R 0	R 13,629	R 13,629	R 13,226	-R 2,420	-R 1,331
4	R 8,459	R 15,176	R 15,176	R 14,231	-R 193	R 348
5	R 10,573	R 17,299	R 17,299	R 15,313	R 1,573	R 2,155
6	R 12,688	R 18,832	R 18,832	R 16,477	R 4,099	R 4,099
7	R 14,803	R 20,359	R 20,359	R 17,729	R 6,191	R 6,191
8	R 16,917	R 21,879	R 21,879	R 19,076	R 8,442	R 8,442
9	R 19,032	R 23,394	R 23,394	R 20,526	R 10,864	R 10,864
10	R 21,147	R 24,903	R 24,903	R 22,086	R 13,470	R 13,470
11	R 23,261	R 26,406	R 26,406	R 23,765	R 16,274	R 16,274
12	R 25,376	R 27,904	R 27,904	R 25,571	R 19,291	R 19,291
13	R 27,491	R 29,395	R 29,395	R 27,514	R 22,538	R 22,538
14	R 29,605	R 30,881	R 30,881	R 29,605	R 26,031	R 26,031
15	R 31,720	R 32,360	R 32,360	R 31,720	R 29,790	R 29,790
16	R 33,835	R 33,835	R 33,835	R 33,835	R 33,835	R 33,835
Grand Total	R 274,905	R 361,902	R 361,902	R 345,006	R 161,955	R 179,072

Table 30: Value per model for yield class P.4 (pine)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,412	R 5,412	R 8,190	-R 17,018	-R 8,086
1	R 0	R 8,441	R 8,441	R 8,813	-R 10,708	-R 6,920
2	R 0	R 10,825	R 10,825	R 9,482	-R 7,849	-R 5,665
3	R 0	R 12,575	R 12,575	R 10,203	-R 5,404	-R 4,315
4	R 6,525	R 13,704	R 13,704	R 10,978	-R 3,404	-R 2,863
5	R 8,157	R 15,393	R 15,393	R 11,813	-R 1,882	-R 1,300
6	R 9,788	R 16,466	R 16,466	R 12,711	R 381	R 381
7	R 11,419	R 17,518	R 17,518	R 13,677	R 2,191	R 2,191
8	R 13,050	R 18,550	R 18,550	R 14,716	R 4,138	R 4,138
9	R 14,682	R 19,561	R 19,561	R 15,834	R 6,233	R 6,233
10	R 16,313	R 20,552	R 20,552	R 17,038	R 8,487	R 8,487
11	R 17,944	R 21,524	R 21,524	R 18,333	R 10,912	R 10,912
12	R 19,576	R 22,476	R 22,476	R 19,726	R 13,522	R 13,522
13	R 21,207	R 23,410	R 23,410	R 21,225	R 16,330	R 16,330
14	R 22,838	R 24,325	R 24,325	R 22,838	R 19,352	R 19,352
15	R 24,470	R 25,222	R 25,222	R 24,470	R 22,603	R 22,603
16	R 26,101	R 26,101	R 26,101	R 26,101	R 26,101	R 26,101
Grand Total	R 212,070	R 302,054	R 302,054	R 266,147	R 83,983	R 101,099

Table 31: Value per model for yield class P.5 (pine)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,412	R 5,412	R 6,673	-R 18,516	-R 9,583
1	R 0	R 8,211	R 8,211	R 7,181	-R 12,319	-R 8,531
2	R 0	R 10,335	R 10,335	R 7,726	-R 9,583	-R 7,399
3	R 0	R 11,807	R 11,807	R 8,314	-R 7,269	-R 6,181
4	R 5,317	R 12,645	R 12,645	R 8,945	-R 5,411	-R 4,870
5	R 6,646	R 14,039	R 14,039	R 9,625	-R 4,041	-R 3,460
6	R 7,975	R 14,806	R 14,806	R 10,357	-R 1,942	-R 1,942
7	R 9,304	R 15,550	R 15,550	R 11,144	-R 309	-R 309
8	R 10,634	R 16,270	R 16,270	R 11,991	R 1,448	R 1,448
9	R 11,963	R 16,967	R 16,967	R 12,902	R 3,338	R 3,338
10	R 13,292	R 17,642	R 17,642	R 13,883	R 5,372	R 5,372
11	R 14,621	R 18,296	R 18,296	R 14,938	R 7,561	R 7,561
12	R 15,951	R 18,929	R 18,929	R 16,073	R 9,916	R 9,916
13	R 17,280	R 19,542	R 19,542	R 17,295	R 12,450	R 12,450
14	R 18,609	R 20,136	R 20,136	R 18,609	R 15,177	R 15,177
15	R 19,938	R 20,711	R 20,711	R 19,938	R 18,111	R 18,111
16	R 21,267	R 21,267	R 21,267	R 21,267	R 21,267	R 21,267
Grand Total	R 172,798	R 262,564	R 262,564	R 216,861	R 35,250	R 52,366

3.3 Value per model for yield class (wattle)

Table 32: Value per model for yield class W.1 (wattle)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,032	R 5,032	R 25,521	R 5,516	R 13,741
1	R 0	R 9,732	R 9,732	R 27,461	R 13,163	R 16,598
2	R 0	R 14,216	R 14,216	R 29,548	R 17,759	R 19,673
3	R 16,447	R 18,236	R 18,236	R 31,793	R 22,110	R 22,982
4	R 21,929	R 22,816	R 22,816	R 34,210	R 25,948	R 26,542
5	R 27,412	R 27,130	R 27,412	R 36,810	R 30,373	R 30,373
6	R 32,894	R 31,752	R 32,894	R 39,607	R 34,494	R 34,494
7	R 38,377	R 36,703	R 38,377	R 42,617	R 38,929	R 38,929
8	R 43,859	R 42,008	R 43,859	R 45,856	R 43,701	R 43,701
9	R 49,341	R 47,692	R 49,341	R 49,341	R 48,836	R 48,836
10	R 54,824	R 53,782	R 54,824	R 54,824	R 54,361	R 54,361
11	R 60,306	R 60,306	R 60,306	R 60,306	R 60,306	R 60,306
Grand Total	R 345,389	R 369,406	R 377,045	R 477,894	R 395,496	R 410,537

Table 33: Value per model for yield class W.2 (wattle)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,032	R 5,032	R 20,764	R 493	R 8,718
1	R 0	R 9,356	R 9,356	R 22,342	R 7,758	R 11,194
2	R 0	R 13,352	R 13,352	R 24,040	R 11,944	R 13,858
3	R 13,381	R 16,769	R 16,769	R 25,867	R 15,853	R 16,725
4	R 17,841	R 20,638	R 20,638	R 27,832	R 19,215	R 19,810
5	R 22,302	R 24,112	R 24,112	R 29,948	R 23,129	R 23,129
6	R 26,762	R 27,765	R 27,765	R 32,224	R 26,700	R 26,700
7	R 31,222	R 31,607	R 31,607	R 34,673	R 30,542	R 30,542
8	R 35,683	R 35,647	R 35,683	R 37,308	R 34,677	R 34,677
9	R 40,143	R 39,896	R 40,143	R 40,143	R 39,126	R 39,126
10	R 44,604	R 44,365	R 44,604	R 44,604	R 43,913	R 43,913
11	R 49,064	R 49,064	R 49,064	R 49,064	R 49,064	R 49,064
Grand Total	R 281,002	R 317,603	R 318,124	R 388,806	R 302,415	R 317,456

Table 34: Value per model for yield class W.3 (wattle)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,032	R 5,032	R 18,747	-R 1,635	R 6,590
1	R 0	R 9,176	R 9,176	R 20,172	R 5,468	R 8,904
2	R 0	R 12,942	R 12,942	R 21,705	R 9,479	R 11,394
3	R 12,082	R 16,083	R 16,083	R 23,355	R 13,201	R 14,073
4	R 16,109	R 19,631	R 19,631	R 25,130	R 16,362	R 16,956
5	R 20,136	R 22,734	R 22,734	R 27,039	R 20,058	R 20,058
6	R 24,163	R 25,967	R 25,967	R 29,094	R 23,396	R 23,396
7	R 28,190	R 29,337	R 29,337	R 31,306	R 26,988	R 26,988
8	R 32,218	R 32,849	R 32,849	R 33,685	R 30,852	R 30,852
9	R 36,245	R 36,510	R 36,510	R 36,245	R 35,011	R 35,011
10	R 40,272	R 40,324	R 40,324	R 40,272	R 39,485	R 39,485
11	R 44,299	R 44,299	R 44,299	R 44,299	R 44,299	R 44,299
Grand Total	R 253,714	R 294,884	R 294,884	R 351,048	R 262,965	R 278,007

Table 35: Value per model for yield class W.4 (wattle)

Age	SV	CV	MAX(CV,SV)	DCF1	DCF2	NDSV
0	R 0	R 5,032	R 5,032	R 14,998	-R 5,594	R 2,631
1	R 0	R 8,795	R 8,795	R 16,138	R 1,209	R 4,645
2	R 0	R 12,090	R 12,090	R 17,364	R 4,897	R 6,811
3	R 9,665	R 14,674	R 14,674	R 18,684	R 8,270	R 9,142
4	R 12,887	R 17,589	R 17,589	R 20,104	R 11,057	R 11,651
5	R 16,109	R 19,974	R 19,974	R 21,631	R 14,350	R 14,350
6	R 19,331	R 22,413	R 22,413	R 23,275	R 17,254	R 17,254
7	R 22,552	R 24,905	R 24,905	R 25,044	R 20,378	R 20,378
8	R 25,774	R 27,453	R 27,453	R 26,948	R 23,740	R 23,740
9	R 28,996	R 30,057	R 30,057	R 28,996	R 27,358	R 27,358
10	R 32,218	R 32,719	R 32,719	R 32,218	R 31,251	R 31,251
11	R 35,439	R 35,439	R 35,439	R 35,439	R 35,439	R 35,439
Grand Total	R 202,971	R 251,138	R 251,138	R 280,839	R 189,609	R 204,651

APPENDIX 4: MODEL VALUATION CALCULATION EXAMPLES

4.1 Standing value calculation example

For a G.1 yield class eucalypt compartment the MAI(t) is 24 t/ha/yr (see Table 3.2) while the standing/stumpage price is R 236.32/tonne. For a 3.5 ha compartment of 6 year old eucalypt with yield class G.1, the Standing Value is calculated as follows:

Standing Value	=	Standing Value/ha x ha
	=	(Age x MAI(t) x Price per tonne (R)) x ha
	=	(6 years x 24 t/ha/annum x R 236.32) x 3.5 hectares
	=	R 119,105.28

If a stand is younger than the age at which trees are deemed to be utilisable (1.5 years for a G.1 yield class as shown in Table 3.2), then zero utilisable volume, and hence zero standing value exists. Tables containing the Standing Value per age class and yield class, generated per genus, can be referenced in appendix 2.1.

4.2 Cost value calculation example

The IRR for the eucalypt Yield Class 1 (G.1) was calculated based on the establishment and maintenance costs (Table 3.3), and the annual recurring costs (Table 3.4). IRR for different yield classes of the same species will differ based on the final volume available for harvesting and thus the change in harvesting income. The IRR where NPV for the cash flow is zero was calculated to be 8.44% for a G.1 yield class (Table 3.7).

Based on an IRR of 8.44% (for yield class G.1), a land value of R14,000, and the costs (Tables 3.3 and 3.4), the cost value for each year of a eucalypt Yield Class 1 (G.1) rotation was calculated and is presented in Table 36.

Table 36: Cost value per year for eucalypt yield class G.1

Operations	Age	Silvicultural Costs	Annual Recurring Expenses	Total Expenditure	Interest			Cost Value per hectare (Expenditure + Interest)
					Land Interest per year	Compounded Interest	Total Interest	
	Years	**Rands (ZAR)/ha**						
Establishment	0	4,664.79		4,664.79			0	4,664.79
Weed Control	1	1,396.65	1,654.67	3,051.32	1,182.24	393.92	1,576.16	9,292.27
Weed Control	2	465.55	1,654.67	2,120.22	1,182.24	784.69	1,966.94	13,379.43
	3		1,654.67	1,654.67	1,182.24	1,129.84	2,312.08	17,346.18
	4		1,654.67	1,654.67	1,182.24	1,464.81	2,647.06	21,647.91
	5		1,654.67	1,654.67	1,182.24	1,828.08	3,010.32	26,312.89
	6		1,654.67	1,654.67	1,182.24	2,222.02	3,404.26	(*)31,371.82
	7		1,654.67	1,654.67	1,182.24	2,649.22	3,831.46	36,857.96
Brashing	8	391.97	1,654.67	2,046.64	1,182.24	3,112.50	4,294.74	43,199.34
	9		1,654.67	1,654.67	1,182.24	3,648.01	4,830.25	49,684.26
Clearfelling	10		1,654.67	1,654.67	1,182.24	4,195.63	5,377.87	56,716.80

Based on costs referred to previously (summarised here in Table 36), the cost value per hectare for a 6 year old eucalypt stand with yield class G.1 is calculated as follows:

Cost Value per hectare at year 6(CV_6):
= $CY_6(1+IRR)^{(6-6)} + CY_5(1+IRR)^{(6-5)} + CY_4(1+IRR)^{(6-4)} + CY_3(1+IRR)^{(6-3)} + CY_2(1+IRR)^{(6-2)} + CY_1(1+IRR)^{(6-1)} + CY_0(1+IRR)^{(6-0)}$

= $(1,182.24 + 1,654.67)(1.0844)^0 + (1,182.24 + 1,654.67)(1.0844)^1 + (1,182.24 + 1,654.67)(1.0844)^2 + (1,182.24 + 1,654.67)(1.0844)^3 + (1,182.24 + 1,654.67 + 465.55)(1.0844)^4 + (1,182.24 + 1,654.67 + 1,396.65)(1.0844)^5 + (4,664.79)(1.0844)^6$

= R 31,371.82/ha (*: corresponding to value per hectare for age 6 in Table 36)

Based on this value per hectare, the value for a 3.5 ha compartment of 6 year old eucalypt with yield class G.1 is calculated as follows:

Cost Value	=	Cost Value/ha x ha
	=	R 31,371.82 x 3.5
	=	R 109,801.37

Tables containing the Cost Value per age class and yield class, generated per genus, can be referenced in appendix 2.2.

4.3 MAX(CV,SV) calculation example

Based on the previous calculations for a 6 year old eucalypt stand with yield class G.1, the Cost Value per hectare is R 31,371.82 and the Standing Value per hectare is R34,030.08. The MAX(CV,SV) value per hectare is therefore R 34,030.08

MAX(CV,SV) per hectare	=	MAX(R34,030.08, R 31,371.82)
	=	R 34,030.08/ha

MAX(CV,SV) for 3.5 hectares	=	MAX(CV,SV) per hectare x hectares
	=	R 34,030.08 x 3.5 hectares
	=	R119,105.28

Tables containing the MAX(CV,SV) Value per age class and yield class, generated per genus, can be referenced in appendix 2.3.

4.4 DCF1 calculation example

To illustrate how this is done on a practical level, a gum tree which is 6 years old will reach its "maturity" age (as discussed in chapter 4.2.1.4.1) at age 8, and the DCF1 value is calculated by discounting the future standing value for a period of 2 years (from the maturity age of 8 to the current age of 6) at the relevant interest rate.

If the stand happened to be greater than the maturity age (8 years or older) then the SV would be used. However, using the previous example of a 6 year old eucalypt stand of yield class G.1 where the Standing Value at maturity age (R 45,373 at 8 years old) has previously been calculated (Appendix 2), the DCF1 value can be calculated using an interest rate of 7.6% (default interest rate as derived in chapter 3.3.1.3) as follows:

DCF1 Value per hectare	=	Standing Future Value per hectare / $(1+\text{Discount Rate})^{d}$
	=	R 45,373.44 / $(1+0.076)^{(8-6)}$
	=	R 39,190.17

and following this, the DCF1 value for a 3.5 ha compartment of 6 year old eucalypt with yield class G.1 is calculated as follows:

DCF1	=	DCF1/ha x ha
	=	R 39,190.17 x 3.5
	=	R 137,165.60

Tables containing the DCF1 Value per age class and yield class, generated per genus, can be referenced in appendix 2.4.

4.5 DCF2 calculation example

In line with the consistent example used thus far, the Yield Class G.1 data will again be used when performing calculations.

The DCF2 value is calculated in the following way:
DCF2 value per hectare = Discounted Revenue - Discounted Expenditure

4.5.1 Discounted revenue

The revenue per hectare (R 56,716.80) at fell age (10 years) is calculated with the standing value methodology described by the standing value method (appendix 2.1).

So for one hectare of 6 year old eucalypt using a discount rate of 7.6%:

Discounted Revenue (Yr6) = R 56,716.80 /$(1.076)^{(10-6)}$
= R 42,311.91

Using a discount rate of 7.6%, this revenue is discounted year by year to year zero, as illustrated below in Table 37.

Table 37: DCF2 discounted expenditure per age class for yield class G.1

Age	Discounted Revenue (Rands)
0	R 27,263.96
1	R 29,336.03
2	R 31,565.56
3	R 33,964.55
4	R 36,545.85
5	R 39,323.34
6	R 42,311.91
7	R 45,527.62
8	R 48,987.71
9	R 52,710.78
10	R 56,716.80

4.5.2 Discounted expenditure

Table 38 below shows the total expenditure per year for eucalypt, and is extracted from Table 3.3.

Table 38: DCF2 expenditure per age class for yield class G.1

Operations	Age Years	Silvicultural Costs	All Overhead Costs	Total Expenditure
		Rands (ZAR)/ha		
Establishment	0	R 4,664.79	R 1,654.67	R 6,319.46
Weed control	1	R 1,396.65	R 1,654.67	R 3,051.32
Weed control	2	R 465.55	R 1,654.67	R 2,120.22
	3		R 1,654.67	R 1,654.67
	4		R 1,654.67	R 1,654.67
	5		R 1,654.67	R 1,654.67
	6		R 1,654.67	R 1,654.67
	7		R 1,654.67	R 1,654.67
Brashing	8	R 391.97	R 1,654.67	R 2,046.64
	9		R 1,654.67	R 1,654.67
Clearfelling	10			

Using the total expenditure per year (Table 38) the total discounted expenditure per age class is calculated using the default discount rate of 7.6% (Table 39). As an example, the total expenditure for year 6 (R1,654.67 in Table 38) is placed in the age class 6 row under year 6 expenses in Table 39, and discounted back to year 0 (R1,066.20).

Table 39: DCF2 discounted expenditure per year

Age Class	Year 0 Expenses	Year 1 Expenses	Year 2 Expenses	Year 3 Expenses	Year 4 Expenses	Year 5 Expenses	Year 6 Expenses	Year 7 Expenses	Year 8 Expenses	Year 9 Expenses	Total Discounted Expenditure per Age Class
	Discounted Expenditure in Rands (ZAR)										
0	6,319.46	2,835.80	1,831.29	1,328.23	1,234.42	1,147.23	1,066.20	990.89	1,139.05	855.86	18,748.43
1		3,051.32	1,970.46	1,429.18	1,328.23	1,234.42	1,147.23	1,066.20	1,225.62	920.90	13,373.56
2			2,120.22	1,537.80	1,429.18	1,328.23	1,234.42	1,147.23	1,318.77	990.89	11,106.74
3				1,654.67	1,537.80	1,429.18	1,328.23	1,234.42	1,418.99	1,066.20	9,669.49
4					1,654.67	1,537.80	1,429.18	1,328.23	1,526.84	1,147.23	8,623.95
5						1,654.67	1,537.80	1,429.18	1,642.88	1,234.42	7,498.95
6							1,654.67	1,537.80	1,767.73	1,328.23	6,288.43
7								1,654.67	1,902.08	1,429.18	4,985.93
8									2,046.64	1,537.80	3,584.44
9										1,654.67	1,654.67
10											0.00

Once all discounted annual expenses have been calculated, the total discounted expenditure per age class can be determined as shown in Table 39. The total expenditure for year 6 (R6,288.43) is made up from year 6 expenses (R 1,654.67), as well as year 7, 8 and 9 expenses discounted to year 6 (R 1,537.80, R 1,767.73 and R 1,328.23 respectively). Year 9 expenses are discounted to year 6 in the following way:

Discounted Expenditure (from year 9 to year 6)

= R $1{,}654.67/(1.076)^{(9-6)}$

= R 1,328.23

Following this, the DFC2 value per age class can be calculated by subtracting the total discounted expenditure per age class from the discounted cash flow per age class. So for the DCF2 value for year 6 can be calculated as follows:

DCF2 Value per hectare = Discounted Revenue - Discounted Expenditure

DCF2 Value (Year 6)	=	R 42,311.91- R 6,288.43
	=	R 36,023.48 per hectare

At this point, the DCF2 value for a 3.5 ha compartment of 6 year old eucalypt with yield class G.1 can be calculated in the following way:

Therefore for 3.5 hectares,

DCF2 Value	=	DCF2 Value per hectare x hectares
	=	R 36,023.48 x 3.5 hectares
	=	R 126,082.18

Tables containing the DCF2 Value per age class and yield class, generated per genus, can be referenced in appendix 2.5.

4.6 NDSV calculation example

The Net Discount Salvage Value (NDSV) model works in exactly the same manner as the 2nd Discounted Cash flow model (DFC2) described above. The only difference occurs in the calculation of discounted expenditure. Instead of discounting the total expenditure to the relevant age class in which a value is required, only annual overhead costs are used, resulting in the following discounted expenditure table which is again calculated for one hectare of eucalypt of yield class 1 (G.1), discounted using a discount rate of 7.6% (Table 40):

Table 40: NDSV discounted expenditure per year

Age Class	Year 0 Annual Overhead Expenses	Year 1 Annual Overhead Expenses	Year 2 Annual Overhead Expenses	Year 3 Annual Overhead Expenses	Year 4 Annual Overhead Expenses	Year 5 Annual Overhead Expenses	Year 6 Annual Overhead Expenses	Year 7 Annual Overhead Expenses	Year 8 Annual Overhead Expenses	Year 9 Annual Overhead Expenses	Total Discounted Expenditure per Age Class
	Discounted Annual Overhead Expenditure in Rands (ZAR)										
0	1,654.67	1,537.80	1,429.18	1,328.23	1234.42	1147.23	1066.2	990.89	920.9	855.86	12,165.38
1		1,654.67	1,537.80	1,429.18	1,328.23	1234.42	1147.23	1066.2	990.89	920.9	11,309.52
2			1,654.67	1,537.80	1,429.18	1,328.23	1234.42	1147.23	1066.2	990.89	10,388.62
3				1,654.67	1,537.80	1,429.18	1,328.23	1234.42	1147.23	1066.2	9,397.73
4					1,654.67	1,537.80	1,429.18	1,328.23	1234.42	1147.23	8,331.53
5						1,654.67	1,537.80	1,429.18	1,328.23	1234.42	7,184.30
6							1,654.67	1,537.80	1,429.18	1,328.23	5,949.88
7								1,654.67	1,537.80	1,429.18	4,621.65
8									1,654.67	1,537.80	3,192.47
9										1,654.67	1,654.67
10											0.00

Using these expenditure values, the NDSV value per age class can be calculated as before, by subtracting the total discounted annual overhead expenditure per age class from the discounted cash flow per age class.

At this point, the NDSV value for a 3.5 ha compartment of 6 year old eucalypt with yield class G.1 can be calculated in the following way:

NDSV Value per hectare	=	Discounted Revenue - Discounted Expenditure
NDSV Value (Year 6)	=	R 42,311.91- R 5,949.88
	=	R 36,362.03/ha

Therefore for 3.5 hectares,

NDSV Value	=	NDSV Value per hectare x hectares
	=	R 36,362.03 x 3.5 hectares
	=	R 127,267.11

Tables containing the NDSV Value per age class and yield class, generated per genus, can be referenced in appendix 2.6.

APPENDIX 5: GROWTH MODEL YIELD TABLES

Table 41: Growth model yield table (MAI(t)) for eucalypt

Eucalypt growth model MAI (tonnes)/ha							
Age	**G.1**	**G.2**	**G.3**	**G.4**	**G.5**	**G.6**	**G.7**
0	0	0	0	0	0	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	6.89	5.56	2.96	2.27	1.68	1.11	0.23
3	14.61	11.91	9.95	7.75	6.60	4.92	3.40
4	18.58	15.85	12.99	10.98	9.66	7.46	5.87
5	20.69	17.99	15.12	12.95	11.28	9.26	7.53
6	22.42	19.22	16.40	14.26	12.43	10.46	8.43
7	23.02	20.16	17.02	15.02	13.12	11.04	9.10
8	23.61	20.62	17.65	15.43	13.63	11.49	9.49
9	23.85	20.94	17.90	15.89	13.89	11.85	9.80
10	24.00	21.00	18.00	16.00	14.00	12.00	10.00

Table 42: Growth model yield table (MAI(t)) for pine

Pine growth model MAI (tonnes)/ha					
Age	**P.1**	**P.2**	**P.3**	**P.4**	**P.5**
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	1.64	1.45	1.23	0.57	0.22
4	4.43	4.03	3.11	2.40	1.98
5	7.65	6.98	6.04	4.48	3.25
6	11.11	10.01	8.65	6.45	5.30
7	14.15	12.77	11.01	8.42	6.68
8	16.88	15.32	13.42	10.09	8.27
9	19.30	17.57	15.26	11.71	9.40
10	21.41	19.46	16.96	12.98	10.55
11	23.10	21.02	18.32	14.05	11.44
12	24.52	22.25	19.44	14.97	12.13
13	25.65	23.30	20.30	15.64	12.76
14	26.51	24.04	21.04	16.21	13.17
15	27.09	24.63	21.52	16.60	13.54
16	27.50	25.00	21.88	16.88	13.75

Table 43: Growth model yield table (MAI(t)) for wattle

Wattle growth model MAI (tonnes)/ha				
Age	**W.1**	**W.2**	**W.3**	**W.4**
0	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00
2	0.28	0.20	0.17	0.03
3	4.64	3.64	2.88	2.26
4	9.51	7.43	6.17	4.75
5	12.08	9.79	8.71	6.46
6	13.92	10.94	9.70	7.52
7	14.34	11.42	10.29	8.16
8	14.53	11.93	10.41	8.33
9	14.36	11.71	10.30	8.24
10	14.04	11.42	10.23	8.22
11	13.68	11.09	10.00	8.00